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AIRBORNE LABORATORY MEASUREMENT OF AIRCRAFT PERFORMANCE
AND STABILITY AND CONTROL FOR LIGHT AIRCRAFT SUPPLEMENT
(U) AIR FORCE ACADEMY CO K R CRENSHAW 24 JUN 83

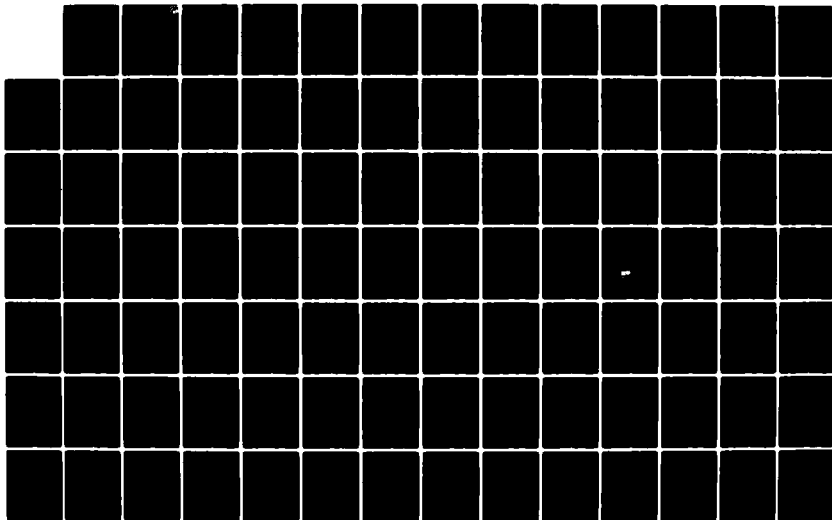
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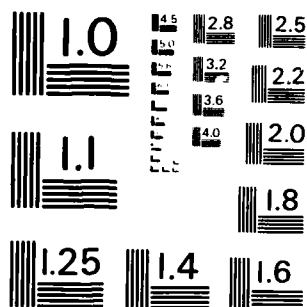
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MICROCOPY RESOLUTION TEST CHART
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Department of Aeronautics
Dean of the Faculty
United States Air Force Academy
Colorado 80840

AIRBORNE LABORATORY MEASUREMENT
OF AIRCRAFT PERFORMANCE AND STABILITY
AND CONTROL FOR LIGHT AIRCRAFT

TECHNICAL NOTE
USAFA-TN-83-3

Crenshaw, K.R.

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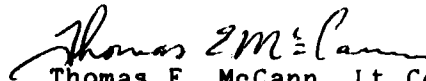
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Thomas E. McCann, Lt Colonel, USAF
Director of Research and Continuing Education

FORWARD

Groundwork on the USAF Academy's Airborne Laboratory, a concept enthusiastically endorsed by Colonel Daniel H. Daley and Lt Colonel Richard C. Oliver, began during the Spring semester of 1982. With the final approval of the Dean of the Faculty and the Superintendent, a new Aero 495 course, "Flight Test Techniques," was taught for the first time during the Fall semester of 1982. Designing the course, planning flight profiles, and handling logistical and other administrative details were accomplished with the help of Captain William C. Roberson. Instrumentation support for measuring important in-flight parameters was provided by Captain Theodore J. Moody of the Department of Electrical Engineering and Mr. Thomas D. Fultz of the Department of Civil Engineering. With the continued support of those mentioned above and the prospective involvement of future members of the Department, the Airborne Laboratory has enormous potential. Aero 495 is expected to become a permanent course in the Aeronautics curriculum by the Fall semester of 1984. What follows is a technical description of the course as it exists today along with sample data and plots.

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AIRBORNE LABORATORY MEASUREMENT OF AIRCRAFT PERFORMANCE AND STABILITY AND CONTROL FOR LIGHT AIRCRAFT

Kent R. Crenshaw*

Abstract

This report is a supplement to the article "Integration of an Airborne Laboratory into the United States Air Force Academy Academic Curriculum" in USAFA-TR-83-2. It contains the test plans, flight test planning guides, and aircraft specifications handouts used during the applications phase of the Department of Aeronautics Airborne Laboratory. Sample calculations and plots from actual flight test data taken by cadets are also included. While the test plans, flight test planning guides, and aircraft specifications were designed to be used with the Beechcraft Sierra and Sundowner, the formats are sufficiently general so that they can be applied to any single-engine, general-aviation aircraft. Commonly recognized flight test techniques are used for gathering data, and data reduction is accomplished using accepted procedures.

I. Introduction

The Department of Aeronautics Airborne Laboratory is divided into two phases: "performance" and "flying qualities." Each student receives two flights during each phase, using the Beech Sierra to evaluate performance and the Beech Sundowner to evaluate flying qualities. The geometry, performance charts, and weight and balance data for each aircraft are shown in Appendix A.

II. Performance

The flying portion of the performance phase is conducted according to a test plan with a format similar to that used at the AFFTC (Air Force Flight Test Center). The test plan, shown in Appendix B, defines specific performance objectives that must

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be met if the advertised performance of the test aircraft is to be verified. It also serves as an administrative tool by dividing the students into two separate test teams and by addressing flying and ground safety considerations. Performance parameters that are evaluated include maximum speed, range and rate-of-climb capability, service ceiling, and glide ratio.

Both performance evaluation flights last approximately one hour with Flight 1 dedicated to gathering aircraft cruise and turn performance data and Flight 2 to gathering aircraft climb and descent data. A "Flight Test Planning Guide," shown in Appendix C, is provided to assist the students in their preparation for each flight. Mission events, pilot and student responsibilities, and post-flight data reduction requirements are clearly defined. In addition, data sheets, data reduction sheets, and an "Initial Flight Test Report" form modeled after AFFTC Form 365 are used. After each flight, the cadets submit for grading a flight report that satisfies the requirements laid out in the "Flight Test Planning Guide." See Appendix D for sample performance data records, data reduction, and plots.

III. Flying Qualities

Like the performance phase of the Airborne Laboratory, the flying qualities phase is conducted according to a test plan. The test plan objectives (shown in Appendix E) are to evaluate the Beech Sundowner 180 C23, both qualitatively and quantitatively, as a primary trainer for Class I as defined in

MIL-F-8785C, "Flying Qualities of Piloted Airplanes." The aircraft is evaluated for compliance with selected paragraphs of this document. The test plan also serves the administrative purpose described in the performance section of this paper.

Both of the flights in the flying qualities phase last approximately one hour. Flight 3 is dedicated to evaluating longitudinal and lateral-directional stability and control as well as maneuvering flight. Flight 4 concerns dynamic stability and stalls. A "Flight Test Planning Guide," shown in Appendix F, outlines each flight in detail and helps the student to prepare for flying and to reduce post-flight data. See Appendix G for sample flying qualities data records, data reduction, and plots.

IV. Conclusions

While the test plans, flight test planning guides, and aircraft specifications handouts contained in this report were designed to be used with the Beechcraft Sierra and Sundowner, the formats are sufficiently general so that they can be applied to any single-engine, general-aviation aircraft. The test plan serves primarily as a statement of purpose and objectives, but it is also a useful administrative tool for organizing the flight test effort and addressing safety considerations. The flight test planning guide lays out the specific engineering requirements for each flight. While this might be interpreted as "leading the cadets by the hand," taking data in-flight is very different from gathering data in a ground-based laboratory

environment. The flight test planning guide gives the individual without experience in general aviation aircraft all the information he or she needs to fly an effective and efficient flight test mission. It eliminates guesswork about the specific test parameters needed in-flight and makes the flight experience both productive and rewarding.

Symbols

English Symbols

(A)	actual
ALT	altitude
BHP _{iw}	brake horsepower, instrument and weight corrected
BHP _s	standard brake horsepower from engine chart
BHP _t	test brake horsepower from engine chart
C _D	coefficient of drag
C _L	coefficient of lift
C _P	propeller pressure coefficient
c.g. or CG	center of gravity
(dH/dt) _d	rate of climb with density correction applied
(dH/dt) _p	rate of climb corrected for engine power and propulsive efficiency
DEG	degrees

F_e	elevator stick force
F_R	rudder force
FF	fuel flow
F.M.	flight manual
FPM	feet per minute
FPS	feet per second
FT	feet
FWD	forward
g	acceleration of gravity
"g"	load factor
GPH	gallons per hour
GD	ground
H_c	calibrated altitude
H_i	indicated altitude
h_m	stick-fixed maneuver point
h'_m	stick-free maneuver point
h_n	stick-fixed neutral point
h'_n	stick-free neutral point
H_{PI}	indicated pressure altitude
H_s or H_{std}	standard altitude
H_t or H_{test}	test altitude
HP	horsepower
HR	hour
IAS (V_i)	indicated airspeed
IN	inches
J	propeller advance ratio

KIAS	knots, indicated airspeed
KTS	knots
$L/D)_{\max}$	maximum lift over drag ratio
MAC or \bar{c}	mean aerodynamic chord
MAP	manifold pressure
MCP	maximum continuous power
MIN	minutes
MPH	miles per hour
n_t or n_{test}	test load factor
NAM	nautical air miles
OAT	outside air temperature
O/S	overshoots
(P)	predicted from flight manual
p	pressure at altitude
p_o	sea level pressure
PRESS	pressure
q	dynamic pressure
R_t or R_{test}	test turn radius
$R/C)_s$ or $(dH/dt)_{\text{std}}$	standard rate of climb
$R/C)_T$ or $(dH/dt)_t$	test rate of climb
RPM	revolutions per minute
R/S	rate of sink
S	planform area of wing
SAR	specific air range
SE	specific endurance
SEC	seconds

T	period of oscillatory dynamic response
t ₂	time to double amplitude
t _{1/2}	time to 1/2 amplitude
T _a	absolute outside air temperature
T _i	indicated outside air temperature
T _s	standard temperature at altitude
T _t	test temperature at altitude
TACH	tachometer
TED	trailing edge down
TEMP	temperature
TEU	trailing edge up
VCAS (V _c)	calibrated airspeed
V _e	equivalent airspeed
V _{iw}	velocity, instrument and weight corrected
V _t	test indicated airspeed
V _{true}	true airspeed
VVI	vertical velocity indicator
\dot{W}_f	fuel flow in pounds (lb) per hour (hr)
W _s or W _{std}	aircraft standard weight
W _t or W _{test}	aircraft test weight

Greek Symbols

ω_t or ω_{test}	test turn rate
-------------------------------	----------------

η	propeller efficiency
δ	pressure ratio p/p_o
σ	density ratio ρ/ρ_o
ρ	density at altitude
ρ_o	sea level density
ϕ	bank angle
δ_e	elevator stick deflection
δ_R	rudder deflection
δ_a	aileron control wheel deflection
β	sideslip angle
ω_a	actual frequency
ω_n	undamped natural frequency
ξ	damping ratio

References

1. Crenshaw, Kent R., "Integration of an Airborne Laboratory into the United States Air Force Academy Academic Curriculum," Aeronautics Digest, USAFA-TR-83-2, USAF Academy, March 1983.

APPENDIX A

Specifications and Weight and Balance for the Beechcraft Sierra 200 C24R and Sundowner 180 C23

SPECIFICATIONS
AND
WEIGHT AND BALANCE
FOR THE BEECHCRAFT SIERRA 200 C24R

AERO 495

SPRING 1983

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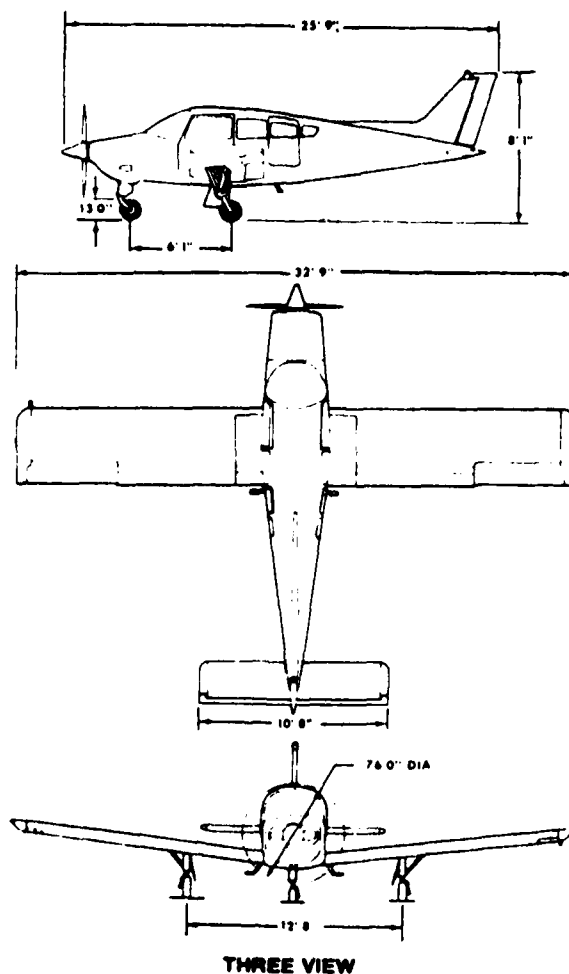
PAGE

I. Geometry	1
II. General	2
III. Performance Charts	3
IV. Weight and Balance	18

I. GEOMETRY

A. Three View

BEECHCRAFT
Sierra C24R



B. Wing

Span, b	32' 9"
Mean Aerodynamic Chord, MAC	52.7"
Area, S	146 ft ²
Aspect Ratio, AR	7.5
Taper Ratio	1.0
Dihedral	6.0°

1. GENERAL

- A. Engine - Avco Lycoming, 4 cylinder
IO-360-A1
Maximum continuous power (at sea level)
200 HP @ 2,700 rpm
Manifold Pressure Operating Range (15" to 28.7" Hg)
- B. Propeller - Two-blade, Hartzell, constant speed
Aluminum alloy
Diameter 76"
Restricted Operation - 2,100 to 2,350 rpm
- C. Capacities
- | | |
|----------------------|---------------------|
| Passengers and Pilot | 6 |
| Oil | 8 quarts |
| Fuel | 59.8 gallons |
| | 57.2 gallons usable |
- D. Design Load Factor
- | | |
|------------------------|--------------|
| 2,750 pounds, flaps up | +3.8 to -1.9 |
|------------------------|--------------|
- E. Airspeeds
- | | |
|---|-----------------|
| Takeoff (flaps 15°) | 66 KTS/76 MPH |
| Climb (best rate, V_y) | 85 KTS/98 MPH |
| Climb (best angle, V_x) | 71 KTS/82 MPH |
| Maximum Glide | 91 KTS/105 MPH |
| Emergency Approach | 74 KTS/85 MPH |
| Normal Approach (flaps down) | 70 KTS/81 MPH |
| Cruise Climb | 96 KTS/110 MPH |
| Maximum Permissible Speed, V_{NE} | 168 KTS/193 MPH |
| Maximum Landing Gear Extended Speed | 135 KTS/155 MPH |
| Maximum Flap Extension Speed | 96 KTS/110 MPH |
| Maneuver Speed | 125 KTS/144 MPH |
| 1G Stall Speed (gear and flaps up, 2,600 lbs) | 65 KTS/75 MPH |

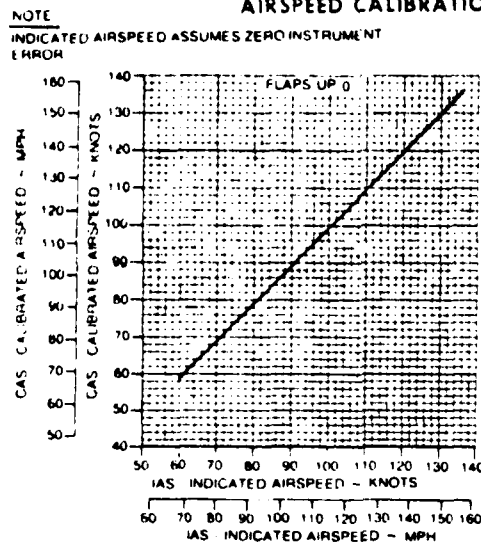
111. PERFORMANCE CHARTS

A. Pitot-Static Calibration Data

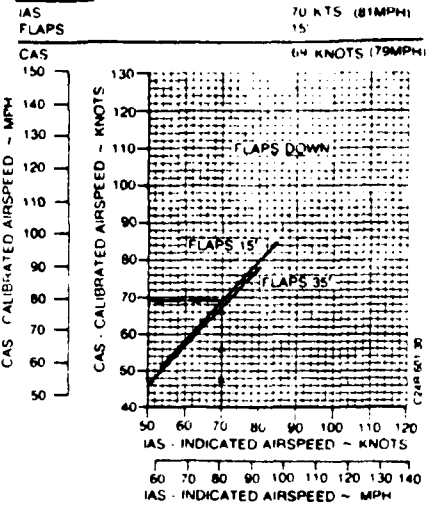
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AIRSPEED CALIBRATION - NORMAL SYSTEM



EXAMPLE



Section V
Performance

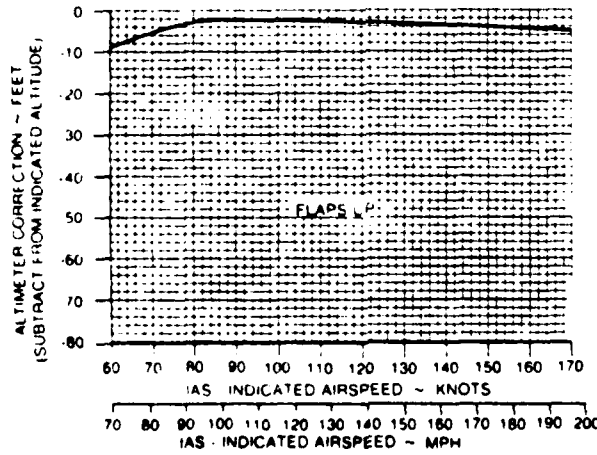
BEECHCRAFT
Sierra C24R

5-12

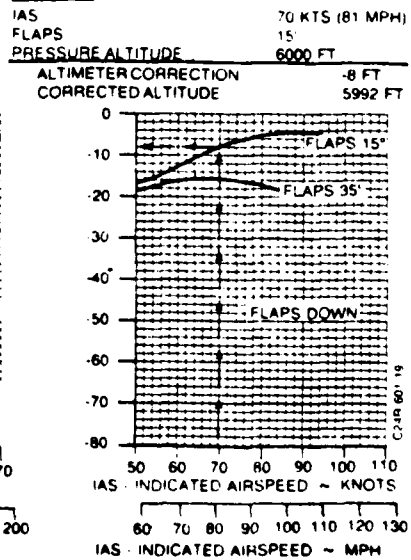
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ALTIMETER CORRECTION-NORMAL SYSTEM

NOTE
INDICATED AIRSPEED ASSUMES ZERO INSTRUMENT ERROR



EXAMPLE



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Performance

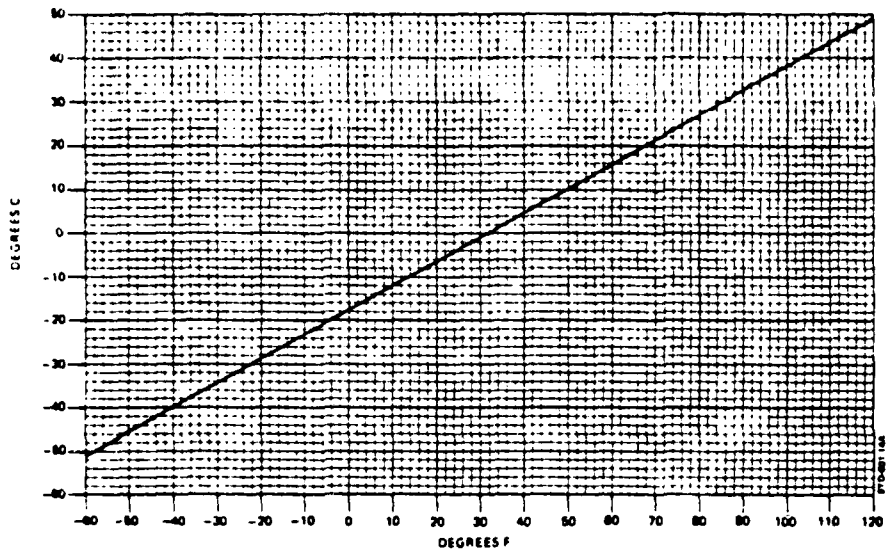
BEECHCRAFT
Sierra C24R

B. Atmospheric Data

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FAHRENHEIT TO CELSIUS TEMPERATURE CONVERSION



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Performance

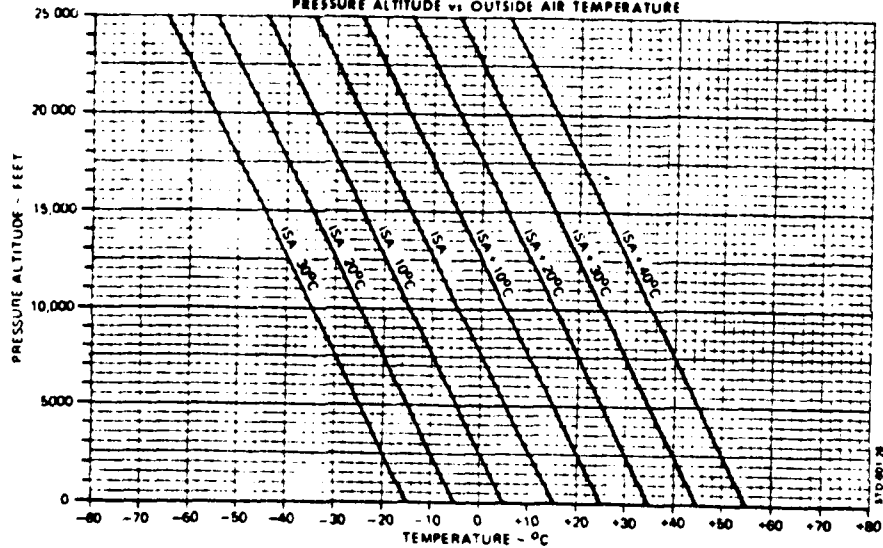
BEECHCRAFT
Sierra C24R

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ISA CONVERSION

PRESSURE ALTITUDE vs. OUTSIDE AIR TEMPERATURE



BEECHCRAFT
Sierra C24R

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Performance

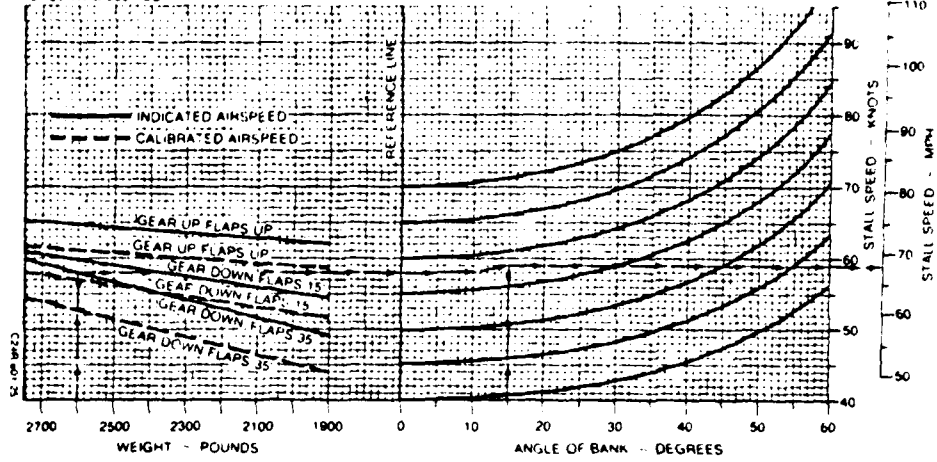
C. Stall Speeds and Crosswinds

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NOTE

MAXIMUM ALTITUDE LOSS EXPERIENCED WHILE CONDUCTING STALLS IN ACCORDANCE WITH CAM 3120 WAS 300 FEET

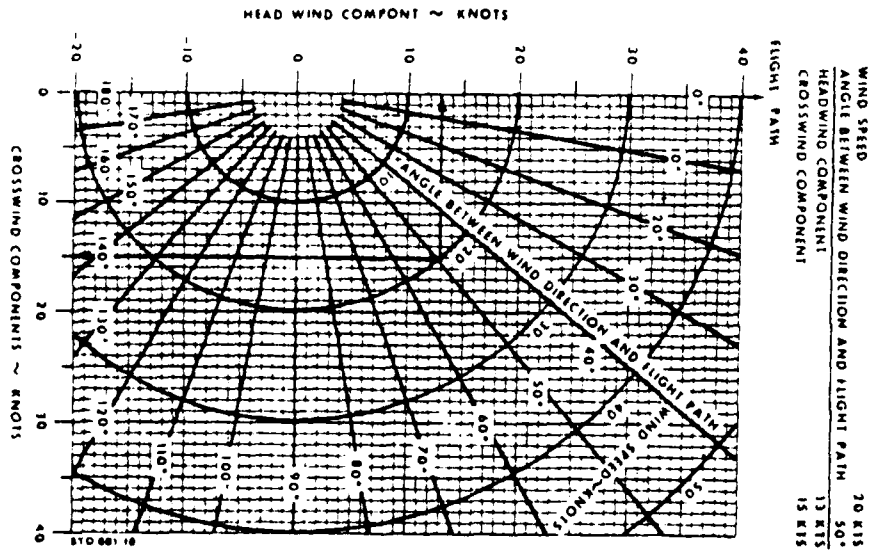


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BEECHCRAFT
Sierra C24R

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BEECHCRAFT
Sierra C24R

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Performance

D. Takeoff and Landing Data

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TAKE-OFF DISTANCE - HARD SURFACE

CLIMB SPEED IN KNOTS (78 MPH)
WIND SPEED IN KNOTS (12 MPH)

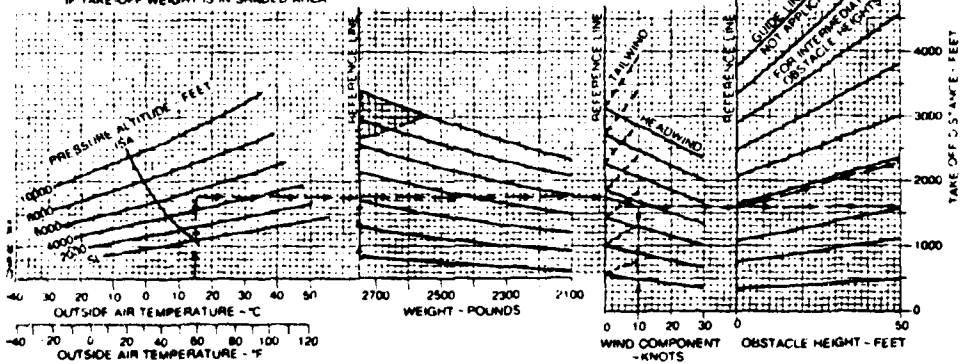
ASSOCIATED CONDITIONS

POWER IN TAKE-OFF POWER SET BEFORE BRAKE RELEASE
FLAPS CLEAN
CLIMB LEAN TO APPROPRIATE ALTITUDE
MIXTURE PAVED LEVEL DRY SURFACE
RUNWAY
NOTE CLIMB PERFORMANCE AFTER LIFT-OFF IS LESS THAN 150 FT/MIN
IF TAKE-OFF WEIGHT IS IN SHADED AREA

EXAMPLE

OAT 15°C (59°F)
PRESSURE ALTITUDE 5800 FT
TAKE-OFF WEIGHT 2750 LBS
HEADWIND COMPONENT 12 KTS
GROUND ROLL 1800 FT
TOTAL DISTANCE OVER 50 FT OBSTACLE 4200 FT

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Performance

BEECHCRAFT
Sierra C24R

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LANDING DISTANCE—HARD SURFACE

ASSOCIATED CONDITIONS

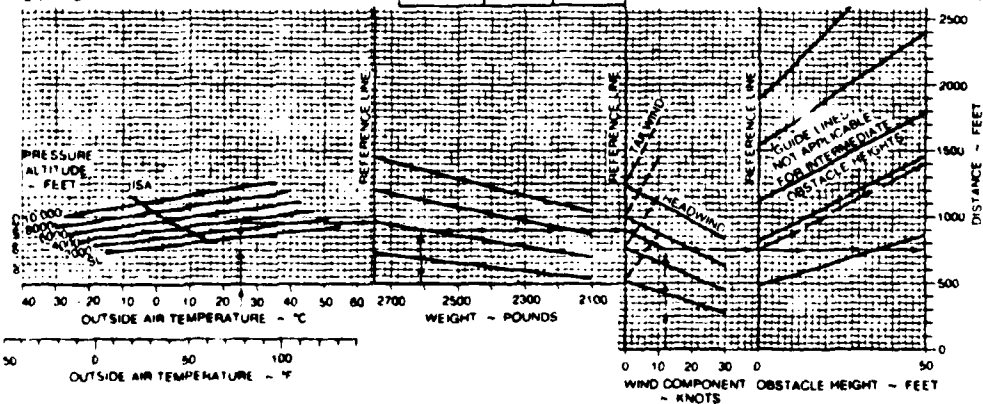
POWER RETARD TO MAINTAIN 800 FT/MIN ON FINAL APPROACH
FLAPS DOWN (35°)
RUNWAY PAVED HARD DRY SURFACE
APPROACH SPEED IAS AS TABULATED
BRAKING MAXIMUM

WEIGHT POUNDS	APPROACH SPEED	
	KNOTS	MPH
2750	70	81
2500	66	75
2300	62	71
2100	58	67

EXAMPLE

OAT 25°C (77°F)
PRESSURE ALTITUDE 3925 FT
LANDING WEIGHT 2600 LBS
HEADWIND COMPONENT 12 KTS
GROUND ROLL 750 FT
TOTAL OVER 50 FT OBSTACLE 1400 FT
APPROACH SPEED 68 KTS (78 MPH)

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BEECHCRAFT
Sierra C24R

Section V
Performance

E. Climb Data

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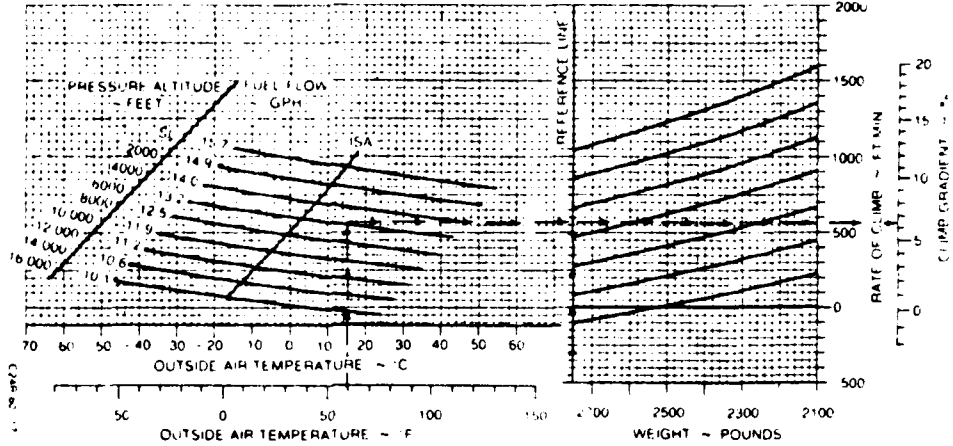
NORMAL CLIMB CLIMB SPEED - 85 KNOTS (98 MPH)

ASSOCIATED CONDITIONS

POWER: FULL THROTTLE AT 2700 RPM
FLAPS: UP (10°)
LANDING GEAR: UP
MIXTURE: LEAN TO APPROPRIATE FUEL FLOW

EXAMPLE

OAT: 15°C (59°F)
PRESSURE ALTITUDE: 5650 FT
WEIGHT: 2750 LBS
RATE OF CLIMB: 570 FT/MIN
CLIMB GRADIENT: 6.2%
CLIMB SPEED: 85 KTS (98 MPH)



Section V
Performance

BEECHCRAFT
Sierra C24R

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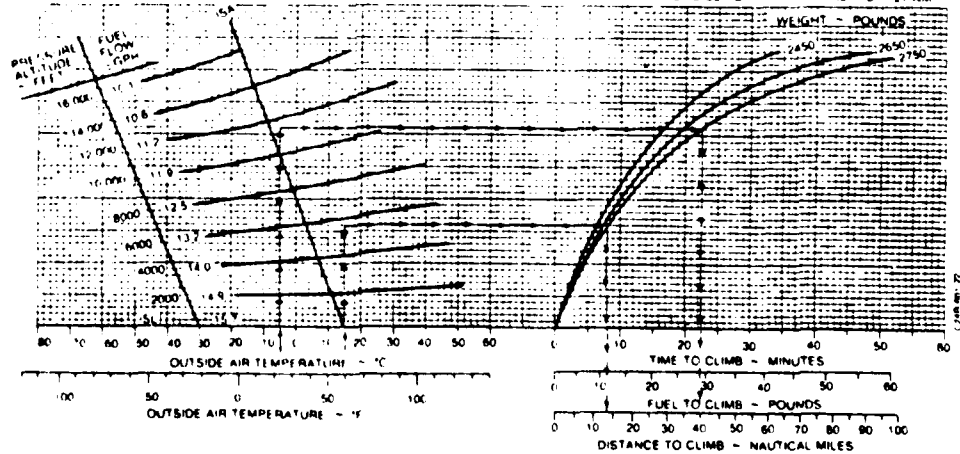
TIME, FUEL AND DISTANCE TO CLIMB CLIMB SPEED - 96 KNOTS (110 MPH)

ASSOCIATED CONDITIONS

PROPELLER SPEED: 2700 RPM
POWER: FULL THROTTLE
FUEL DENSITY: 6.0 LBS PER GALLON
FLAPS: UP
GEAR: UP
MIXTURE: LEAN TO APPROPRIATE FUEL FLOW

EXAMPLE

OAT AT TAKE-OFF: 15°C (59°F)
OAT AT CRUISE: 5°C (23°F)
AIRPORT PRESSURE ALTITUDE: 5650 FT
CRUISE ALTITUDE: 11,500 FT
INITIAL CLIMB WEIGHT: 2750 LBS
TIME TO CLIMB: 23.8 = 15 MIN
FUEL TO CLIMB: 28.5 = 17 LBS
DISTANCE TO CLIMB: 40.13 = 27 NM



BEECHCRAFT
Sierra C24R

Section V
Performance

F. Cruise Data

CRUISE POWER SETTINGS - 2700 RPM 75% MCP (or FULL THROTTLE) - 2600 POUNDS

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PRESS ALT.	ISA -36°F (-20°C)								STANDARD DAY (ISA)								ISA +36°F (+20°C)							
	OAT		MAN. PRESS		FUEL FLOW		TAS		OAT		MAN. PRESS		FUEL FLOW		TAS		OAT		MAN. PRESS		FUEL FLOW		TAS	
	FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH	FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH	FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH
SL		25	-4	22.4	61	10.2	123	142	61	16	23.0	61	10.2	125	144	99	37	23.6	61	10.2	128	147		
1000		21	-6	22.1	61	10.2	124	143	57	14	22.7	61	10.2	126	145	95	35	23.3	61	10.2	129	148		
2000		18	-8	21.6	61	10.2	125	144	55	13	22.4	61	10.2	128	147	91	33	23.0	61	10.2	130	150		
3000		14	-10	21.6	61	10.2	126	145	52	11	22.2	61	10.2	129	148	88	31	22.8	61	10.2	131	151		
4000		12	-11	21.3	61	10.2	127	146	48	9	22.0	61	10.2	130	150	84	29	22.5	61	10.2	133	153		
5000		9	-13	21.1	61	10.2	128	147	45	7	21.7	61	10.2	131	151	81	27	22.3	61	10.2	134	154		
6000		5	-15	20.9	61	10.2	129	148	41	5	21.5	61	10.2	132	152	77	25	22.1	61	10.2	135	155		
7000		1	-17	20.7	61	10.2	131	151	37	3	21.3	61	10.2	133	153	73	23	21.9	61	10.2	136	157		
8000		2	-19	20.5	61	10.2	132	152	34	1	21.1	61	10.2	135	155	70	21	21.8	61	10.2	137	158		
9000		4	-21	20.3	61	10.2	133	153	30	-1	20.9	61	10.2	136	157	66	19	21.5	60	10.2	137	158		
10000		-9	-23	20.2	61	10.2	134	154	27	-3	20.7	61	10.2	137	158	63	17	20.7	59	9.8	137	158		
11000		-13	-25	20.0	60	10.2	134	154	23	-5	20.0	59	9.8	136	157	59	15	20.0	57	9.5	136	157		
12000		-17	-27	19.2	59	9.8	134	154	19	-7	19.2	58	9.7	134	154	55	13	19.2	56	9.3	134	154		
13000		-20	-29	18.5	58	9.7	133	153	16	-9	18.5	56	9.3	133	153	52	11	18.5	54	9.0	132	152		
14000		-24	-31	17.9	56	9.3	131	151	12	-11	17.9	54	9.0	131	151	48	9	17.9	53	8.8	130	150		

NOTES 1 Shaded area represents operation with full throttle
2 Full throttle manifold settings are approximate

Section V
Performance

BEECHCRAFT
Sierra C24R

CRUISE POWER SETTINGS - 2500 RPM 75% MCP (or FULL THROTTLE) - 2600 POUNDS

November, 1980

5-23

PRESS ALT.	ISA -36°F (-20°C)								STANDARD DAY (ISA)								ISA +36°F (+20°C)							
	OAT		MAN. PRESS		FUEL FLOW		TAS		OAT		MAN. PRESS		FUEL FLOW		TAS		OAT		MAN. PRESS		FUEL FLOW		TAS	
	FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH	FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH	FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH
SL		25	-4	23.6	61	10.2	123	142	61	16	24.4	61	10.2	126	145	99	37	25.1	61	10.2	129	148		
1000		21	-6	23.5	61	10.2	124	143	59	15	24.1	61	10.2	127	146	95	35	24.8	61	10.2	130	150		
2000		18	-8	23.3	61	10.2	125	144	55	13	23.9	61	10.2	128	147	91	33	24.5	61	10.2	131	151		
3000		16	-9	23.0	61	10.2	127	146	52	11	23.6	61	10.2	129	148	83	31	24.2	61	10.2	132	152		
4000		12	-11	22.7	61	10.2	128	147	48	9	23.4	61	10.2	130	150	84	29	24.0	61	10.2	133	153		
5000		9	-13	22.5	61	10.2	129	148	45	7	23.1	61	10.2	131	151	81	27	23.7	61	10.2	134	154		
6000		5	-15	22.3	61	10.2	130	150	41	5	22.9	61	10.2	132	152	77	25	23.5	61	10.2	135	155		
7000		1	-17	22.1	61	10.2	131	151	37	3	22.7	61	10.2	134	154	73	23	23.2	60	10.0	135	155		
8000		2	-19	21.8	61	10.2	132	152	34	1	22.4	60	10.0	134	154	70	21	22.4	59	9.8	134	154		
9000		-8	-21	21.6	60	10.0	132	152	30	-1	21.6	59	9.8	133	153	66	19	21.6	57	9.5	133	153		
10000		-9	-23	20.8	59	9.8	131	151	27	-3	20.8	57	9.5	132	152	63	17	20.8	56	9.3	131	151		
11000		-13	-25	20.1	57	9.5	130	150	23	-5	20.1	56	9.3	130	150	59	15	20.1	54	9.0	130	150		
12000		-17	-27	19.3	55	9.2	129	148	19	-7	19.3	54	9.0	128	147	55	13	19.3	53	8.8	127	146		
13000		-20	-29	18.6	54	9.0	127	146	16	-9	18.6	53	8.8	127	146	52	11	18.6	51	8.5	125	144		
14000		-24	-31	17.9	53	8.8	126	145	12	-11	17.9	52	8.7	125	144	48	9	17.9	50	8.3	123	142		

NOTES 1 Shaded area represents operation with full throttle
2 Full throttle manifold settings are approximate

BEECHCRAFT
Sierra C24R

Section V
Performance

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November, 1980

CRUISE POWER SETTINGS - 2400 RPM **65% MCP (or FULL THROTTLE) - 2600 POUNDS**

	ISA -36°F (-20°C)								STANDARD DAY (ISA)								ISA +36°F (+20°C)							
PRESS ALT.	OAT		MAN PRESS	FUEL FLOW		TAS		OAT		MAN PRESS	FUEL FLOW		TAS		OAT		MAN PRESS	FUEL FLOW		TAS				
FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH	°F	°C	IN HG	PPH	GPH	KTS	MPH	°F	°C	IN HG	PPH	GPH	KTS	MPH			
SL	25	-4	22.3	54	9.0	116	134	61	16	22.9	54	9.0	118	136	97	36	23.5	54	9.0	120	138			
1000	21	-6	22.0	54	9.0	117	135	57	14	22.6	54	9.0	119	137	93	34	23.2	54	9.0	121	139			
2000	18	-8	21.7	54	9.0	118	136	54	12	22.3	54	9.0	120	138	90	32	23.0	54	9.0	122	140			
3000	14	-10	21.5	54	9.0	118	136	50	10	22.1	54	9.0	121	139	86	30	22.7	54	9.0	123	142			
4000	10	-12	21.2	54	9.0	119	137	46	8	21.8	54	9.0	122	140	84	29	22.4	54	9.0	124	143			
5000	7	-14	20.9	54	9.0	120	138	43	6	21.5	54	9.0	123	142	81	27	22.2	54	9.0	125	144			
6000	3	-16	20.7	54	9.0	121	139	41	5	21.3	54	9.0	124	143	77	25	22.0	54	9.0	126	145			
7000	1	-17	20.5	54	9.0	122	140	37	3	21.1	54	9.0	125	144	73	23	21.7	54	9.0	127	146			
8000	-2	-19	20.3	54	9.0	123	142	34	1	20.9	54	9.0	126	145	70	21	21.5	54	9.0	128	146			
9000	-6	-21	20.1	54	9.0	124	143	30	-1	20.7	54	9.0	126	145	66	19	21.3	54	9.0	127	146			
10000	-9	-23	19.9	54	9.0	125	144	27	-3	20.5	54	9.0	127	146	63	17	21.1	54	9.0	127	146			
11000	-13	-25	19.8	54	9.0	125	144	23	-5	20.1	53	8.8	126	145	59	15	20.1	52	8.7	126	145			
12000	-17	-27	19.3	54	9.0	125	144	19	-7	19.3	52	8.7	125	144	55	13	19.3	51	8.5	123	142			
13000	-20	-29	18.6	52	8.7	124	143	16	-9	18.6	51	8.5	123	142	52	11	18.6	49	8.2	120	138			
14000	-24	-31	17.9	51	8.5	121	139	12	-11	17.9	49	8.2	120	138	48	9	17.9	48	8.0	117	135			

NOTES 1 Shaded area represents operation with full throttle
 2 Full throttle manifold settings are approximate

Section V
PerformanceBEECHCRAFT
Sierra C24R

November, 1980

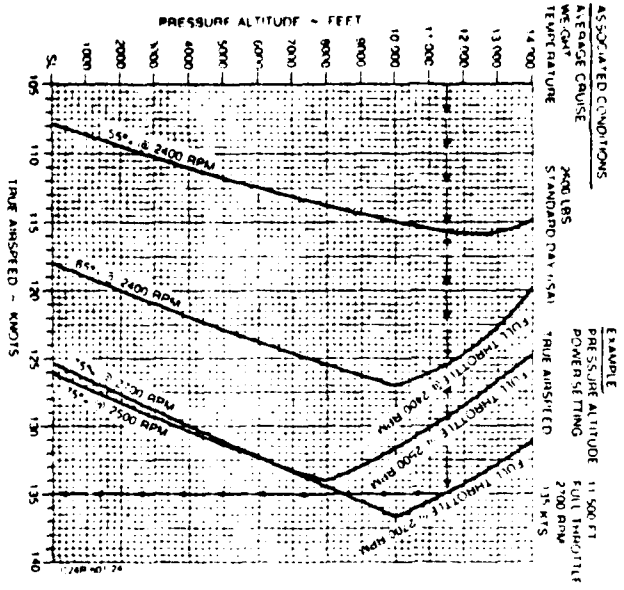
S-25

CRUISE POWER SETTINGS - 2400 RPM **55% MCP - 2600 POUNDS**

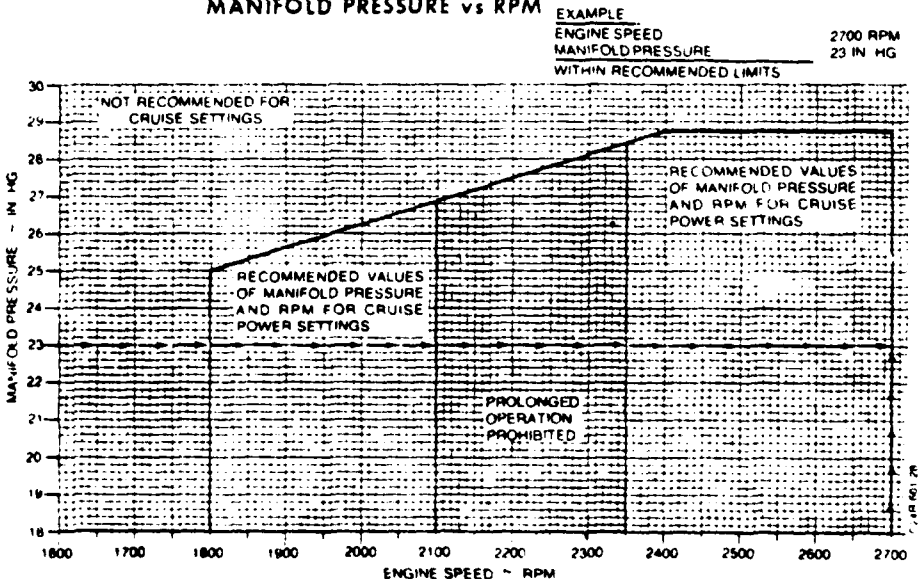
	ISA -36°F (-20°C)								STANDARD DAY (ISA)								ISA +36°F (+20°C)							
PRESS ALT.	OAT		MAN PRESS	FUEL FLOW		TAS		OAT		MAN PRESS	FUEL FLOW		TAS		OAT		MAN PRESS	FUEL FLOW		TAS				
FEET	°F	°C	IN HG	PPH	GPH	KTS	MPH	°F	°C	IN HG	PPH	GPH	KTS	MPH	°F	°C	IN HG	PPH	GPH	KTS	MPH			
SL	25	-4	19.7	48	8.0	106	122	61	16	20.3	48	8.0	106	124	97	36	20.8	48	8.0	110	127			
1000	21	-6	19.6	48	8.0	107	123	57	14	20.1	48	8.0	108	124	93	34	20.6	48	8.0	110	127			
2000	18	-8	19.3	48	8.0	107	123	54	12	19.8	48	8.0	109	125	90	32	20.3	48	8.0	111	128			
3000	14	-10	19.1	48	8.0	108	124	50	10	19.6	48	8.0	110	127	86	30	20.1	48	8.0	112	129			
4000	10	-12	18.9	48	8.0	109	125	46	8	19.4	48	8.0	111	126	82	28	19.9	48	8.0	113	130			
5000	7	-14	18.6	48	8.0	110	127	43	6	19.1	48	8.0	112	129	79	26	19.7	48	8.0	113	130			
6000	3	-16	18.4	48	8.0	111	128	39	4	18.9	48	8.0	113	130	75	24	19.4	48	8.0	114	131			
7000	0	-18	18.2	48	8.0	111	128	36	2	18.7	48	8.0	113	130	72	22	19.2	48	8.0	115	132			
8000	-4	-20	18.0	48	8.0	112	129	32	0	18.5	48	8.0	114	131	68	20	19.1	48	8.0	115	132			
9000	-8	-22	17.8	48	8.0	113	130	28	-2	18.3	48	8.0	114	131	64	16	18.9	48	8.0	116	134			
10000	-11	-24	17.6	48	8.0	114	131	25	-4	18.1	48	8.0	115	132	61	16	18.7	48	8.0	116	134			
11000	-15	-26	17.5	48	8.0	114	131	21	-6	18.0	48	8.0	116	134	57	14	18.5	48	8.0	117	135			
12000	-18	-28	17.3	48	8.0	115	132	18	-8	17.8	48	8.0	116	134	55	13	18.3	48	8.0	117	135			
13000	-22	-30	17.1	48	8.0	115	132	14	-10	17.6	48	8.0	116	134	50	10	18.1	48	8.0	117	135			
14000	-26	-32	16.8	48	8.0	116	134	10	-12	17.4	48	8.0	117	135	46	8	18.0	48	8.0	117	135			

BEECHCRAFT
Sierra C24RSection V
Performance

CRUISE SPEEDS



MANIFOLD PRESSURE vs RPM



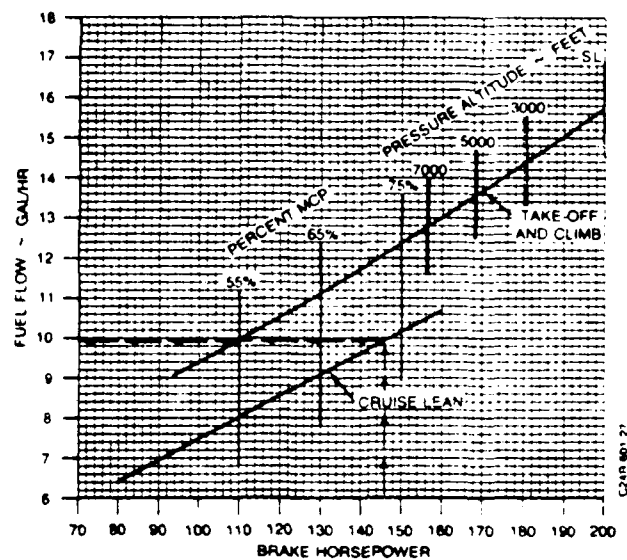
Section V
Performance

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Sierra C24R

FUEL FLOW vs BRAKE HORSEPOWER

EXAMPLE

BRAKE HORSEPOWER	146 HP
CONDITION	LEVEL FLIGHT CRUISE LEAN
FUEL FLOW	9.95 GAL/HR



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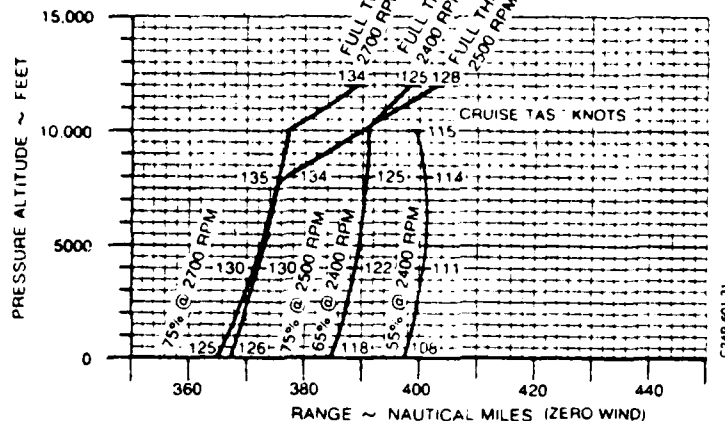
RANGE PROFILE - 37 GALLONS

ASSOCIATED CONDITIONS STANDARD DAY

WEIGHT 2758 LBS BEFORE ENGINE START
FUEL 100 OCTANE AVIATION GASOLINE
FUEL DENSITY 6.0 LBS/GAL
INITIAL FUEL LOADING 37 U.S. GAL (222 LBS)

NOTE

RANGE INCLUDES START, TAXI, CLIMB, WITH 45 MINUTES RESERVE FUEL AT 55% MAXIMUM CONTINUOUS POWER



BEECHCRAFT
Sierra C24R

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Performance

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ASSOCIATED CONDITIONS

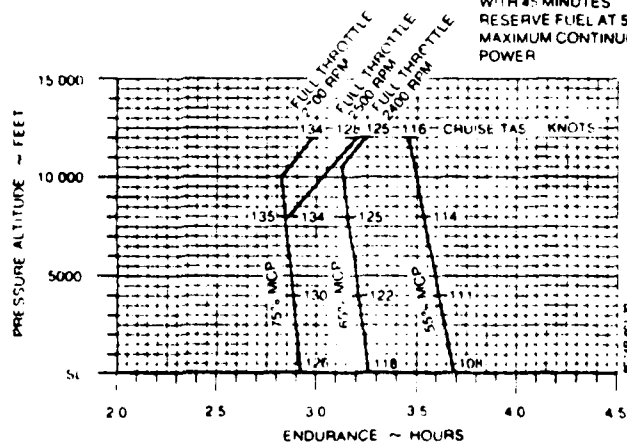
ENDURANCE PROFILE-37 GALLONS

WEIGHT 2758 LBS BEFORE ENGINE START
FUEL 100 OCTANE AVIATION GASOLINE
FUEL DENSITY 6.0 LBS/GAL
INITIAL FUEL LOADING 37 U.S. GALS (222 LBS)

STANDARD DAY

NOTE

ENDURANCE INCLUDES START, TAXI, AND CLIMB, WITH 45 MINUTES RESERVE FUEL AT 55% MAXIMUM CONTINUOUS POWER



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RANGE PROFILE-57 GALLONS

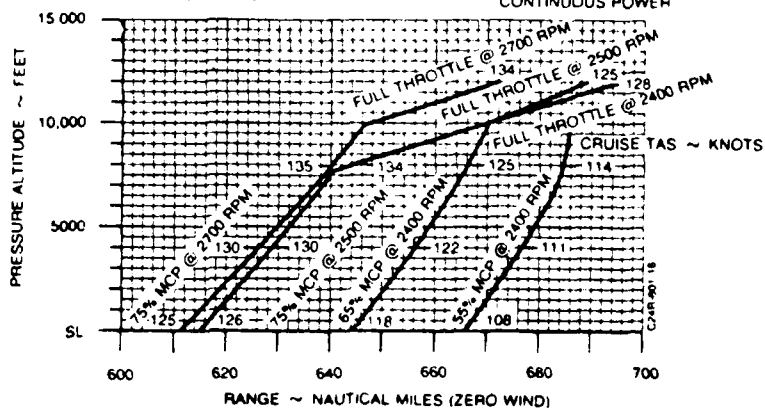
ASSOCIATED CONDITIONS

WEIGHT 2758 LBS BEFORE ENGINE START
 FUEL 100 OCTANE AVIATION GASOLINE
 FUEL DENSITY 6.0 LBS/GAL
 INITIAL FUEL LOADING 57 U.S. GAL (342 LBS)

STANDARD DAY

NOTE

RANGE INCLUDES START, TAXI AND CLIMB WITH 45 MINUTES RESERVE FUEL AT 55% MAXIMUM CONTINUOUS POWER



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Performance

BEECHCRAFT
Sierra C24R

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November, 1980

ENDURANCE PROFILE-57 GALLONS

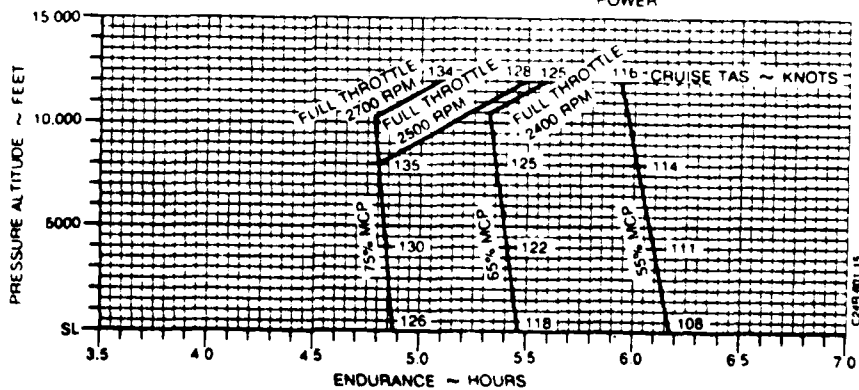
STANDARD DAY (ISA)

ASSOCIATED CONDITIONS

WEIGHT 2758 LBS BEFORE ENGINE START
 FUEL 100 OCTANE AVIATION GASOLINE
 FUEL DENSITY 6.0 LBS/GAL
 INITIAL FUEL LOADING 57 U.S. GAL (342 LBS)

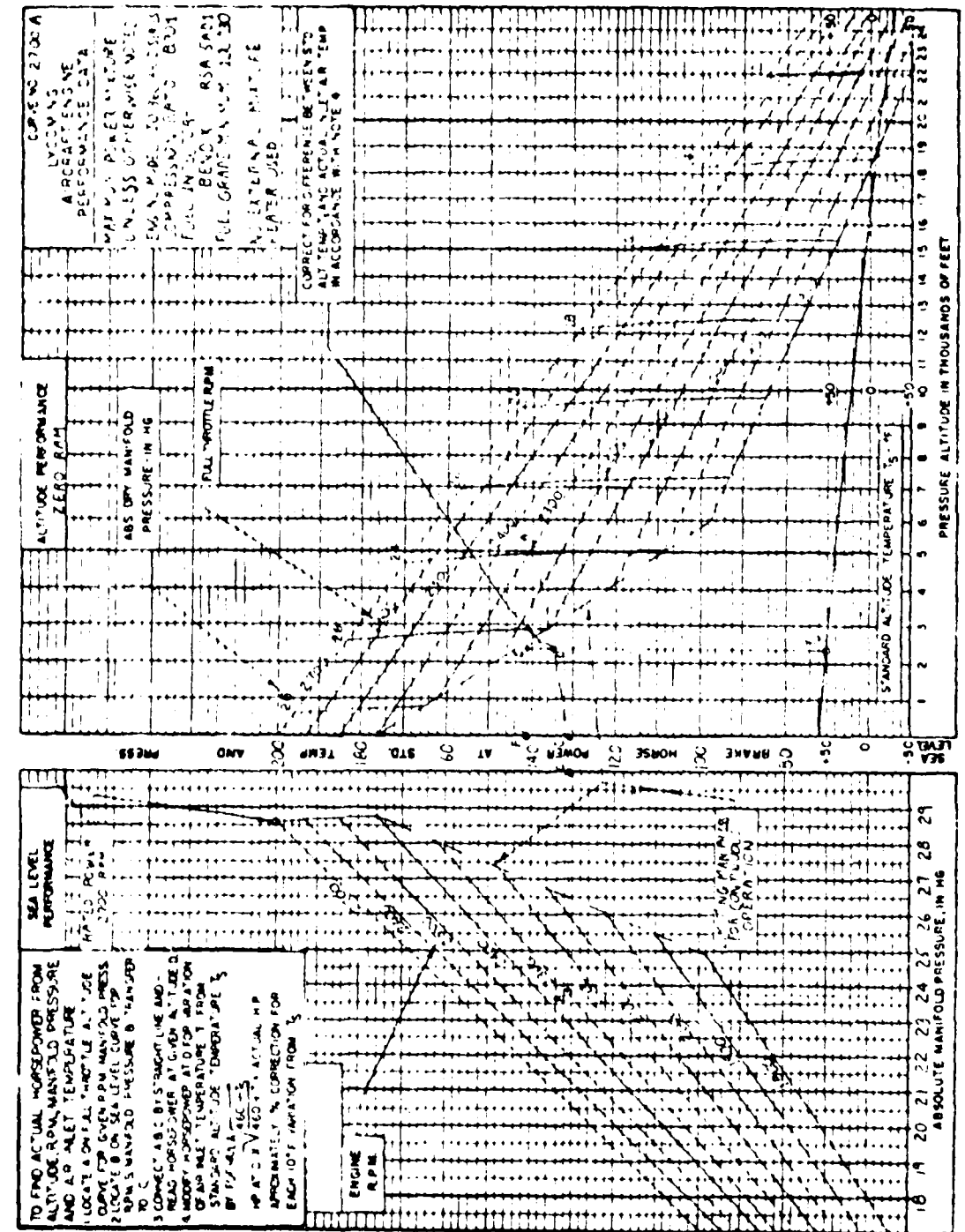
NOTE

ENDURANCE INCLUDES START, TAXI AND CLIMB WITH 45 MINUTES RESERVE FUEL AT 55% MAXIMUM CONTINUOUS POWER



Section V
Performance

BEECHCRAFT
Sierra C24R



Data Source: Courtesy of AVCO Lycoming Williamsport Division

2 BLADES 91 ACTIVITY FACTOR PROPELLER EFFICIENCY

J	Cp	0.03	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21
0.1000	0.2500	0.2100	0.2100	0.2100	0.2100	0.2100	0.2100	0.2100	0.2100	0.2100	0.2100
0.2000	0.4511	0.3300	0.3300	0.3300	0.3300	0.3300	0.3300	0.3300	0.3300	0.3300	0.3300
0.3000	0.5917	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200
0.4000	0.6924	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800
0.5000	0.7596	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100
0.6000	0.7990	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200
0.7000	0.8145	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200	0.5200
0.8000	0.8230	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100
0.9000	0.8269	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
1.0000	0.8269	0.4900	0.4900	0.4900	0.4900	0.4900	0.4900	0.4900	0.4900	0.4900	0.4900
1.1000	0.8269	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800
1.2000	0.8269	0.4700	0.4700	0.4700	0.4700	0.4700	0.4700	0.4700	0.4700	0.4700	0.4700
1.3000	0.8269	0.4600	0.4600	0.4600	0.4600	0.4600	0.4600	0.4600	0.4600	0.4600	0.4600
1.4000	0.8269	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500
1.5000	0.8269	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400	0.4400
1.6000	0.8269	0.4300	0.4300	0.4300	0.4300	0.4300	0.4300	0.4300	0.4300	0.4300	0.4300
1.7000	0.8269	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200	0.4200
1.8000	0.8269	0.4100	0.4100	0.4100	0.4100	0.4100	0.4100	0.4100	0.4100	0.4100	0.4100
1.9000	0.8269	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
2.0000	0.8269	0.3900	0.3900	0.3900	0.3900	0.3900	0.3900	0.3900	0.3900	0.3900	0.3900

Data Source: Courtesy of TRW Hartzell Propeller

BLADE ANGLE AT 0.75R

J	Cp	0.03	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21
0.1000	10.32	16.09	22.41	26.46	28.63	30.19	31.71	33.15	34.4	35.51	36.54
0.2000	11.00	16.40	22.71	26.76	28.93	30.49	32.01	33.45	34.7	35.8	36.83
0.3000	11.30	16.59	22.90	26.95	29.12	30.68	32.20	33.64	34.9	36.0	37.03
0.4000	11.75	17.02	23.33	27.38	29.55	31.11	32.63	34.07	35.3	36.4	37.47
0.5000	12.57	18.52	24.77	28.77	30.94	32.40	33.92	35.36	36.6	37.7	38.71
0.6000	13.25	19.53	25.73	29.73	31.90	33.36	34.88	36.22	37.5	38.6	39.65
0.7000	15.25	20.70	26.90	30.90	33.07	34.55	35.55	36.55	37.6	38.7	39.7
0.8000	16.85	21.97	28.17	32.17	34.34	35.34	36.34	37.34	38.4	39.5	40.5
0.9000	20.60	23.24	29.44	33.44	35.61	36.61	37.61	38.61	39.7	40.8	41.8
1.0000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.1000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.2000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.3000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.4000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.5000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.6000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.7000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.8000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
1.9000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6
2.0000	21.40	24.04	30.24	34.24	36.41	37.41	38.41	39.41	40.5	41.6	42.6

$$J = \frac{V_{IAS} (fps) 60}{N D_p}$$

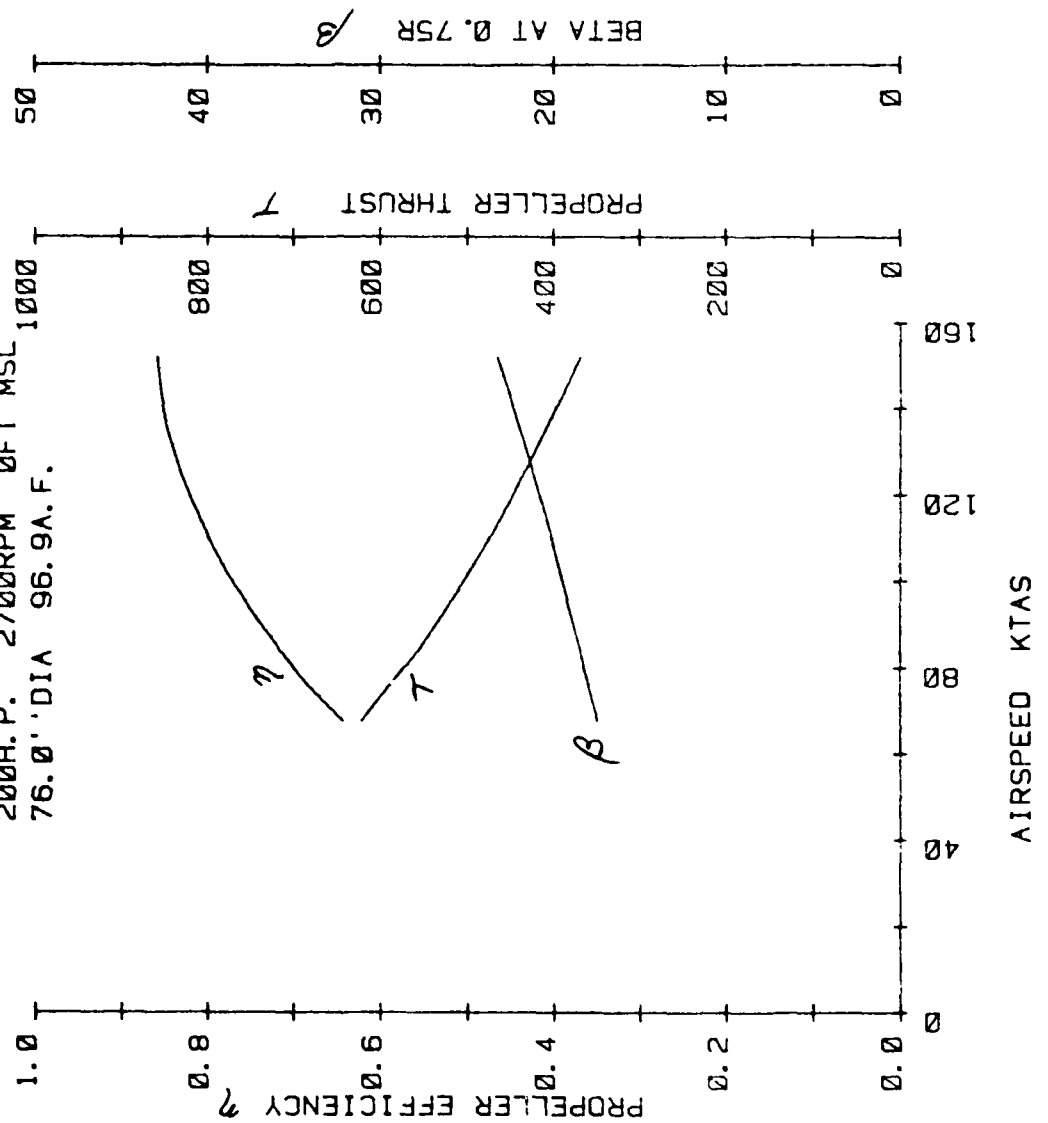
$$C_p = \frac{550 BHP_t (60)^3}{.002377 \sigma N^3 D_p^5}$$

N = RPM

D_p = propeller diameter (ft)

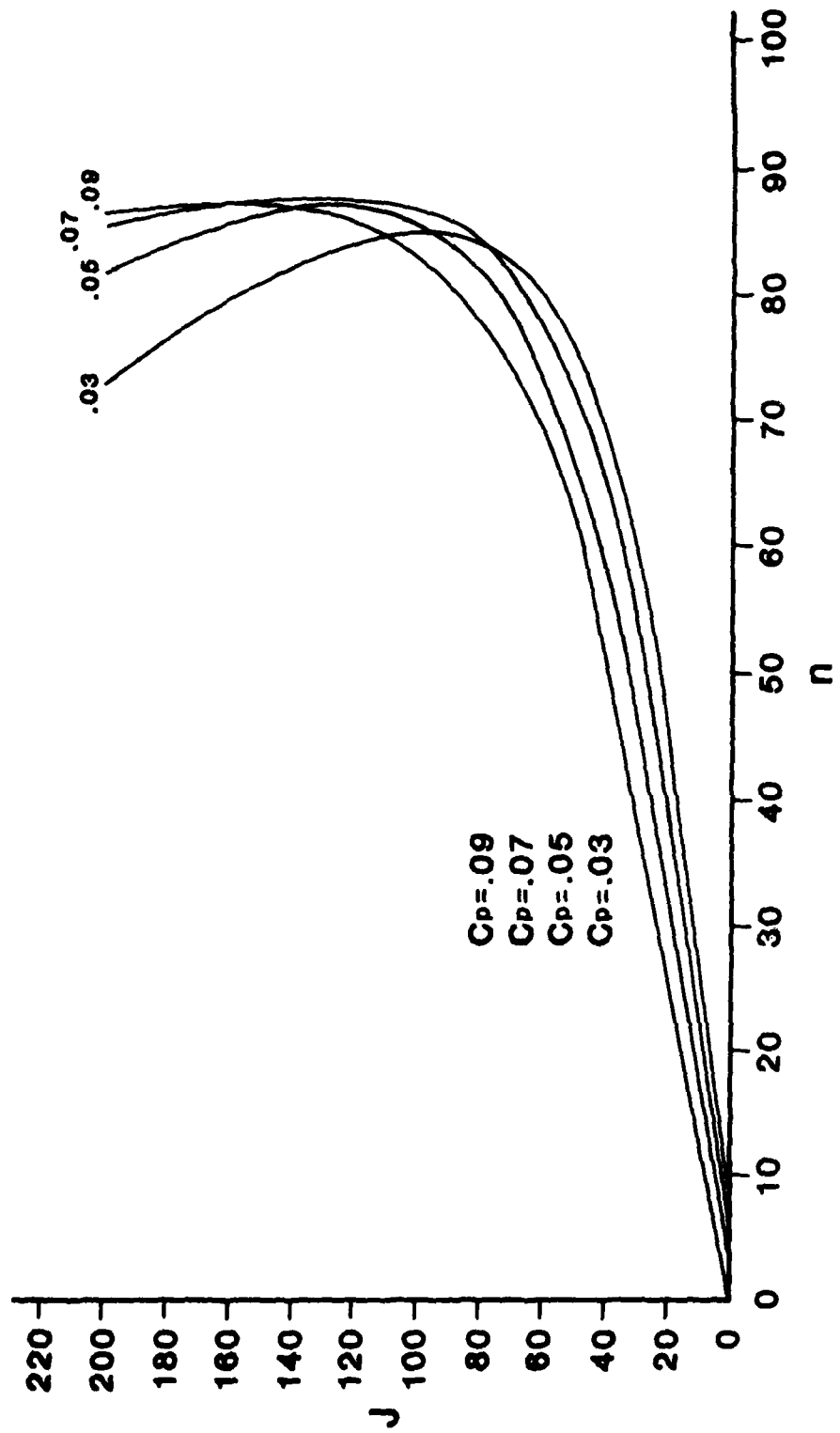
NOTE: Reduce efficiency by 5% for installation blockage effect.

ESTIMATED PERFORMANCE
 HC-M2YR-1BF/F7666A
 Lyc. 10-360-A1B6
 200H.P. 2700RPM 0FT MSL
 76.0" DIA 96.9A.F.



Data Source: Courtesy of TRW Hartzell Propeller

Advance Ratio vs Efficiency Given values of C_p



IV. WEIGHT AND BALANCE

BASIC EMPTY WEIGHT AND BALANCE

SIERRA 200 C24R SER. NO. MC-513 REG. NO. N18892 DATE 10-9-80

JACK POINT LOCATION
FORWARD 129.2 Company
AFT 285.9 Signature

REACTION WHEEL - JACK POINTS	SCALE READING	TARE	NET WEIGHT	ARM	MOMENT
LEFT MAIN	674.5				
RIGHT MAIN	662.0			129.251	172744
NOSE OR TAIL	442.5			57.313	25361
TOTAL (AS WEIGHED)	1779.0		1779.0		198105
Space below provided for additions and subtractions to as - weighed condition					
LESS 8 QT OIL			- 15.0	50	- 750
Plus: Fire Extinguisher			+2.7	107.0	288.9
ELT			+ .6	259.0	155.4
EMPTY WEIGHT			1767.3	111.92	197799
ENGINE OIL			15.0	50.0	750
UNUSABLE FUEL			15.6	125.0	1950
BASIC EMPTY WEIGHT			1797.9	111.52	200499

BASIC EMPTY WEIGHT AND BALANCE

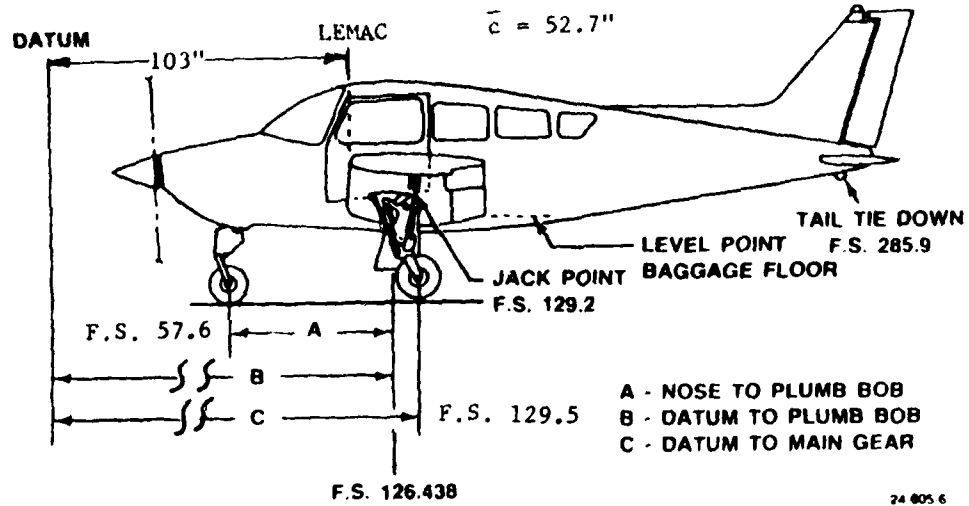
SIERRA 200 C24R SER. NO. MC-690 REG. NO. N6636D DATE 10-9-80

JACK POINT LOCATION
FORWARD 129.2 Company
AFT 285.9 Signature

REACTION WHEEL - JACK POINTS	SCALE READING	TARE	NET WEIGHT	ARM	MOMENT
LEFT MAIN	719.0				
RIGHT MAIN	717.5			129.188	185579
NOSE OR TAIL	396.0			56.563	22399
TOTAL (AS WEIGHED)	1832.5		1832.5		207978
Space below provided for additions and subtractions to as - weighed condition					
LESS 8 QT OIL			- 15.0	50	- 750
Less Aft Ballast Weight			-10.1	288.42	-2913
Plus: ELT			+ 2.7	259.0	+ 699
ELT (correction)			+ 1.0	259.0	+ 259
Fire Extinguisher			+ 5.0	126.0	+ 630
EMPTY WEIGHT			1816.1	113.38	205903
ENGINE OIL			15.0	50.0	750
UNUSABLE FUEL			15.6	125.0	1950
BASIC EMPTY WEIGHT			1846.7	112.96	208603

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November, 1980



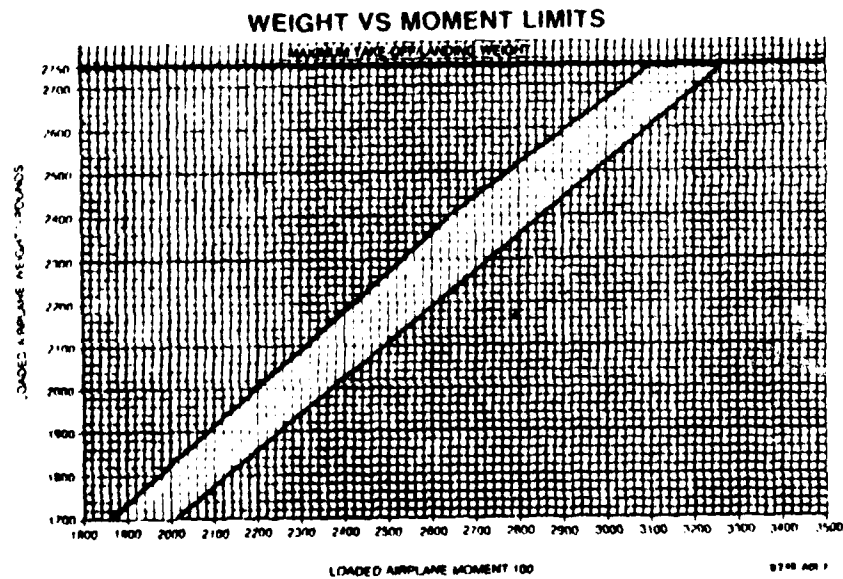
Section VI
Wt & Bal Equip List

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Sierra C24R

24-805-6

6-12

November, 1980



Section VI
Wt & Bal Equip List

BEECHCRAFT
Sierra C24R

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Sierra C24R

Section VI
Wt & Bal/Equip List

MOMENT LIMITS vs WEIGHT

Weight	Minimum Moment 100	Maximum Moment 100	Weight	Minimum Moment 100	Maximum Moment 100	Weight	Minimum Moment 100	Maximum Moment 100
1700	1870	2011	2100	2310	2484	2500	2775	2958
1710	1881	2023	2110	2321	2496	2510	2788	2969
1720	1892	2035	2120	2332	2508	2520	2801	2981
1730	1903	2047	2130	2343	2520	2530	2814	2993
1740	1914	2058	2140	2354	2532	2540	2826	3005
1750	1925	2070	2150	2365	2543	2550	2841	3017
1760	1936	2082	2160	2376	2555	2560	2854	3028
1770	1947	2094	2170	2387	2567	2570	2867	3040
1780	1958	2106	2180	2398	2579	2580	2880	3052
1790	1969	2118	2190	2409	2591	2590	2894	3064
1800	1980	2129	2200	2420	2603	2600	2907	3076
1810	1991	2141	2210	2431	2614	2610	2920	3088
1820	2002	2153	2220	2442	2626	2620	2932	3099
1830	2013	2165	2230	2453	2638	2630	2947	3111
1840	2024	2177	2240	2464	2650	2640	2960	3123
1850	2035	2189	2250	2475	2662	2650	2972	3135
1860	2046	2200	2260	2486	2674	2660	2987	3147
1870	2057	2212	2270	2497	2685	2670	3000	3159
1880	2068	2224	2280	2508	2697	2680	3013	3170
1890	2079	2236	2290	2519	2709	2690	3027	3182
1900	2090	2248	2300	2530	2721	2700	3040	3194
1910	2101	2260	2310	2541	2733	2710	3054	3206
1920	2112	2271	2320	2552	2745	2720	3067	3218
1930	2123	2283	2330	2563	2756	2730	3081	3230
1940	2134	2295	2340	2574	2768	2740	3094	3241
1950	2145	2307	2350	2585	2780	2750	3108	3253
1960	2156	2319	2360	2596	2792			
1970	2167	2331	2370	2607	2804			
1980	2178	2342	2380	2619	2815			
1990	2189	2354	2390	2632	2827			
2000	2200	2366	2400	2645	2839			
2010	2211	2378	2410	2658	2851			
2020	2222	2390	2420	2671	2863			
2030	2233	2401	2430	2684	2875			
2040	2244	2413	2440	2697	2887			
2050	2255	2425	2450	2710	2898			
2060	2266	2437	2460	2721	2910			
2070	2277	2449	2470	2736	2922			
2080	2288	2461	2480	2749	2934			
2090	2299	2472	2490	2762	2946			

The above weight and moment limits are based on the following weight and center of gravity limit data:

NORMAL CATEGORY

WEIGHT CONDITION	FWD CG LIMIT	AFT CG LIMIT
2750 lb (Max Take-Off or Landing)	113.0	118.3
2375 lb (Max)	110.0	116.3

November, 1980

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Section VI
Wt & Bal/Equip List

BEECHCRAFT
Sierra C24R

COMPUTING PROCEDURE

1 Record the Basic Empty Weight and Moment from the Basic Empty Weight and Balance form (or from the latest superseding form) under the Basic Empty Condition block. The moment must be divided by 100 to correspond to Useful Load Weights and Moments tables.

2 Record the weight and corresponding moment from the appropriate table of each of the useful load items (except fuel) to be carried in the airplane.

3 Total the weight column and moment column. The SUB-TOTALS are the ZERO FUEL CONDITION.

4 Determine the weight and corresponding moment for the fuel loading to be used. This fuel loading includes fuel for the flight, plus that required for start, taxi, and takeoff. Add the Fuel Loading Condition to Zero Fuel Condition to obtain the SUB-TOTAL Ramp Condition.

5 Subtract the fuel to be used for start, taxi, and takeoff to arrive at the SUB-TOTAL Take-off Condition.

6 Subtract the weight and moment of fuel to be used from the take-off weight and moment. The SUB-TOTAL Condition of No. 3 and No. 5, as well as the landing condition moment, must be within the minimum and maximum moments shown on the Moment Limits vs Weight graph for that weight. If the total moment is less than the minimum moment allowed, useful load items must be shifted aft, or forward load items reduced. If the total moment is greater than the maximum moment allowed, useful load items must be shifted forward, or aft load items reduced. If the quantity or location of load items is changed, the calculations must be revised and the moments rechecked.

BEECHCRAFT
Sierra C24R

Section VI
Wt & Bal Equip List

WEIGHT AND BALANCE LOADING FORM

MODEL SIERRA C24R DATE XX-XX-XX

SERIAL NO. XXX REG. NO. XXXXXX

	ITEM	WEIGHT	MOM/100
1	BASIC EMPTY CONDITION	1720	1912
2	FRONT SEAT OCCUPANTS	340	374
3	3rd & 4th SEAT OCCUPANTS	340	482
4	5th & 6th SEAT OCCUPANTS	130	222
5	BAGGAGE	—	—
6	CARGO	—	—
7	SUB TOTAL	2530	2990
8	FUEL LOADING (32 gal)	192	225
9	SUB TOTAL RAMP CONDITION	2722	3215
10	*LESS FUEL FOR START, TAXI, and TAKE-OFF	-8	-9
11	SUB TOTAL TAKE-OFF CONDITION	2714	3206
12	LESS FUEL TO DESTINATION (25 gal)	-150	-176
13	LANDING CONDITION	2564	3030

*Fuel for start, taxi and take-off is normally 8 lbs at an average mom/100 of 9.

November, 1980

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Section VI
Wt & Bal Equip List

BEECHCRAFT
Sierra C24R

WEIGHT AND BALANCE LOADING FORM

MODEL SIERRA C24R DATE _____

SERIAL NO. _____ REG. NO. _____

ITEM	WEIGHT	MOM/100
1. BASIC EMPTY CONDITION		
2. FRONT SEAT OCCUPANTS		
3. 3rd & 4th SEAT OCCUPANTS		
4. 5th & 6th SEAT OCCUPANTS		
5. BAGGAGE		
6. CARGO		
7. SUB TOTAL		
8. FUEL LOADING		
9. SUB TOTAL RAMP CONDITION		
10. *LESS FUEL FOR START, TAXI, AND TAKE-OFF		
11. SUB TOTAL TAKE-OFF CONDITION		
12. LESS FUEL TO DESTINATION		
13. LANDING CONDITION		

*Fuel for start, taxi and take-off is normally 8 lbs at an average mom/100 of 9.

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November, 1950

Section VI
Wt & Bal Equip List

BEECHCRAFT
Sierra C24R

WEIGHT AND BALANCE LOADING FORM

MODEL SIERRA C24R DATE _____

SERIAL NO. _____ REG. NO. _____

ITEM	WEIGHT	MOM/100
1. BASIC EMPTY CONDITION		
2. FRONT SEAT OCCUPANTS		
3. 3rd & 4th SEAT OCCUPANTS		
4. 5th & 6th SEAT OCCUPANTS		
5. BAGGAGE		
6. CARGO		
7. SUB TOTAL		
8. FUEL LOADING		
9. SUB TOTAL RAMP CONDITION		
10. *LESS FUEL FOR START, TAXI, AND TAKE-OFF		
11. SUB TOTAL TAKE-OFF CONDITION		
12. LESS FUEL TO DESTINATION		
13. LANDING CONDITION		

*Fuel for start, taxi and take-off is normally 8 lbs at an average mom/100 of 9.

8-16

November, 1950

BEECHCRAFT
Sierra C24R

Section VI
Wt & Bal/Equip List

USEFUL LOAD WEIGHTS AND MOMENTS

OCCUPANTS

WEIGHT	FRONT SEATS				3RD AND 4TH SEATS			
	*FWD POS.		*AFT POS.		BENCH SEAT		SPLIT SEAT	
	**ARM	*ARM	**ARM	*ARM	ARM	ARM	ARM	ARM
	**104	**105	**112	**112	**142	**142	**144	**144
	MOM	MOM	MOM	MOM	MOM	MOM	MOM	MOM
	100	100	100	100	100	100	100	100
120	125	126	134	134	170	173	173	173
130	135	137	146	146	185	187	187	187
140	146	147	157	157	199	202	202	202
150	156	158	168	168	213	216	216	216
160	166	168	179	179	227	230	230	230
170	177	179	190	190	241	245	245	245
180	187	189	202	202	256	259	259	259
190	198	200	213	213	270	274	274	274
200	208	210	224	224	284	288	288	288

*Effective MC 449, MC 452 thru MC 555

†Effective MC 556 and after

*Reclining seat with back in full up position

**Values computed from a C.G. criterion based on a 170 pound male. Differences in physical characteristics can cause variation in center of gravity location

November, 1980

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Section VI
Wt & Bal/Equip List

BEECHCRAFT
Sierra C24R

USEFUL LOAD WEIGHTS AND MOMENTS

5th & 6th SEATS ARM 171			
Weight	<u>Moment</u> 100	Weight	<u>Moment</u> 100
80	137	140	239
90	154	150	257
100	171	160	274
110	188	170	291
120	205	180	308
130	222	190	325
		200	342

USABLE FUEL
ARM 117

GALLONS	WEIGHT	MOMENT/100
5	30	35
10	60	70
15	90	105
20	120	140
22	132	154
25	150	176
27	162	189
30	180	211
32	192	225
35	210	246
37	222	259
40	240	281
45	270	316
50	300	351
52	312	365
57	342	400

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November, 1980

BEECHCRAFT
Sierra C24R

Section VI
Wt & Bal/Equip List

USEFUL LOAD WEIGHTS AND MOMENTS

BAGGAGE

ARM 167

Weight	<u>Moment</u> 100	Weight	<u>Moment</u> 100
10	17	140	234
20	33	150	251
30	50	160	267
40	67	170	284
50	84	180	301
60	100	190	317
70	117	200	334
80	134	210	351
90	150	220	367
100	167	230	384
110	184	240	401
120	200	250	418
130	217	260	434
		270	451

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SPECIFICATIONS
AND
WEIGHT AND BALANCE
FOR THE BEECHCRAFT SUNDOWNER 180 C23

AERO 495

FALL 1982

A-30

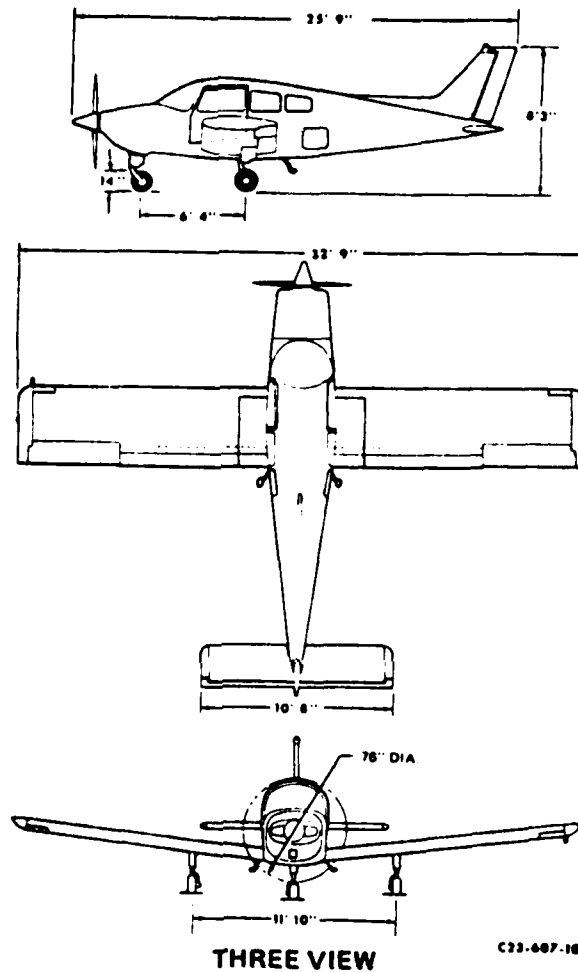
<u>CONTENTS</u>	<u>PAGE</u>
I. GEOMETRY	1
II. GENERAL	2
III. PERFORMANCE CHARTS	3
IV. WEIGHT AND BALANCE	9

1. GEOMETRY

A. Three View

**BEECHCRAFT Sundowner 180
C23 (M-1285 and After)**

**Section I
General**



B. Wing

Span, b	32' 9"
Mean Aerodynamic Chord, MAC	52.7"
Area, S	146 ft ²
Aspect Ratio, AR	7.5
Taper Ratio,	1.0
Dihedral	6.0°

11. GENERAL

A. Engine, Avco Lycoming, 4 cylinder O-360-A

Maximum continuous power (at sea level) 180 HP @ 2,700 rpm

B. Propeller, two bladed, fixed pitch Sensenich, diameter 76"

Restricted Operation 2,150-2,350 rpm

C. Capacities

Crew and Pilot	4
Oil	8 quarts
Fuel	59.8 gallons
	52 gallons usable

D. Design Load Factor

(2,450 pounds, flaps up) +3.8 to -1.9

E. Airspeeds

Takeoff (flaps up)	65 KTS/75 MPH
Climb (best rate)	75 KTS/86 MPH
Climb (best angle)	69 KTS/79 MPH
Max Glide	78 KTS/90 MPH
Emergency App.	68 KTS/78 MPH
Normal App. (flaps down)	68 KTS/78 MPH
Normal App. (flaps up)	80 KTS/92 MPH
1G Stall Speed (flaps up, 2,450 lbs)	63 KTS/72 MPH
Maximum permissible speed, V _{NE}	152 KTS/175 MPH

III. Performance Charts

A. Pitot-Static Calibration Data

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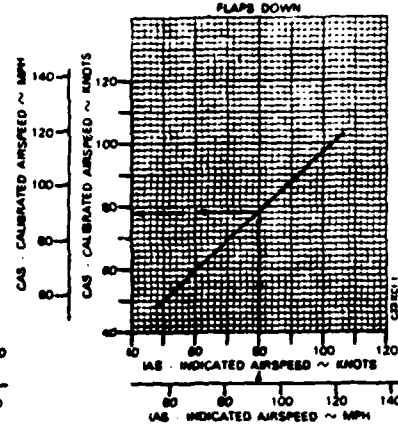
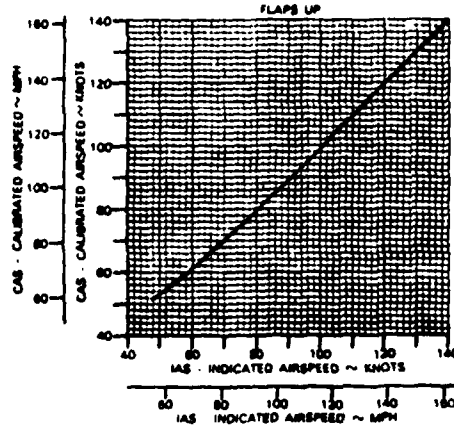
NOTE: INDICATED AIRSPEED ASSUMES ZERO INSTRUMENT ERROR

SPEED ASSUMES ZERO

AIRSPEED CALIBRATION - NORMAL SYSTEM

EXAMPLE

FLAPS DOWN 80 KTS
IAS 80
CAS 78 KTS



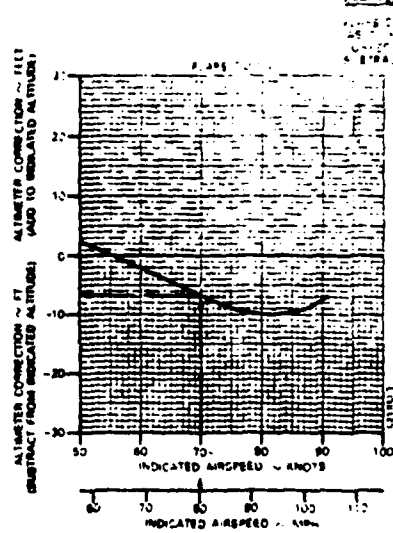
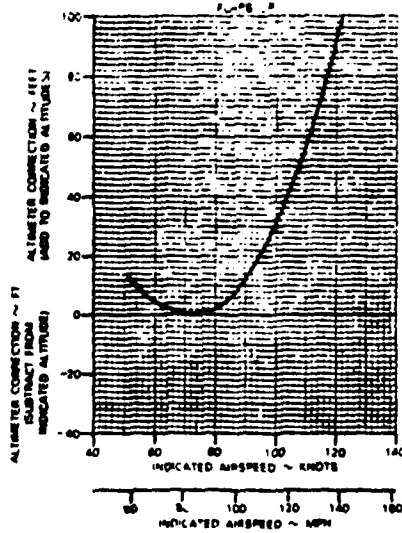
February 1979

Section V
Performance

BEECHCRAFT Sundowner 180
C23 (M-1285 and After)

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ALTIMETER CORRECTION - NORMAL SYSTEM



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Section V
Performance

BEECHCRAFT Sundowner 180
C23 (M-1285 and After)

B. Power-Off Stall Speeds

Section V
Performance

BEECHCRAFT Sundowner 180
C23 (M-1285 and After)

POWER OFF STALL SPEEDS

WEIGHT 2450 LBS:

Maximum altitude loss during a normal stall recovery is approximately 300 ft.

ANGLE OF BANK			
LEVEL	30°	45°	60°
FLAPS-UP			
72 mph 63 kts	77 mph 67 kts	85 mph 74 kts	101 mph 88 kts
FLAPS - DOWN (35°)			
59 mph 51 kts	63 mph 55 kts	70 mph 61 kts	83 mph 72 kts

C. Crosswind Chart

BEECHCRAFT Sundowner 180
C23 (M-1285 and After)

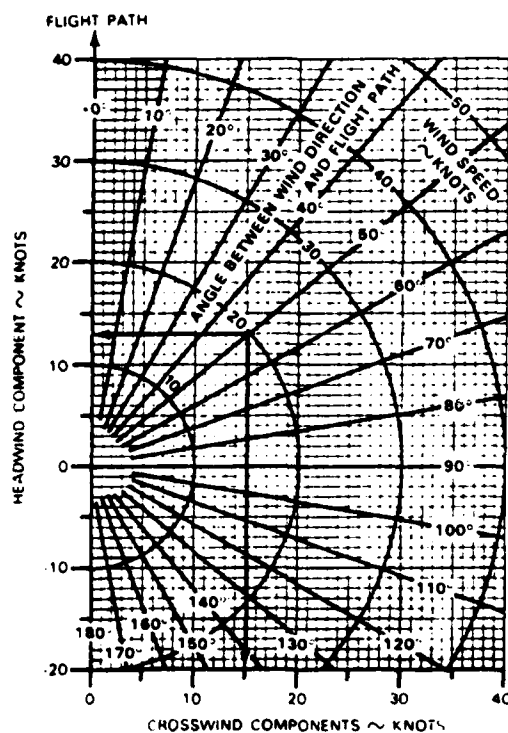
Section V
Performance

WIND COMPONENTS

Demonstrated Crosswind Component is 17kts/20mph

EXAMPLE

WIND SPEED	20 KTS
ANGLE BETWEEN WIND DIRECTION AND FLIGHT PATH	50°
HEADWIND COMPONENT	13 KTS
CROSSWIND COMPONENT	15 KTS



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D. Takeoff and Landing Data

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TAKE-OFF DISTANCE - HARD SURFACE

ASSOCIATED CONDITIONS

POWER FULL THROTTLE
MIXTURE LEAN TO MAXIMUM RPM, THEN ENRICH SLIGHTLY
FLAPS UP
RUNWAY LEVEL, DRY, HARD SURFACE
WEIGHT 2450 LBS

TAKE-OFF SPEEDS

LIFT OFF 65 KTS 75 MPH
AT 50 FT 74 KTS 85 MPH

WIND COMPONENT DOWN RUNWAY KNOTS	SEA LEVEL			2000 FT			4000 FT			6000 FT			8000 FT		
	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET
0	23 5	817	1592	18 9	1048	1805	9 13	1196	2051	2 17	1388	2334	6 21	1589	2862
	41 5	1020	1787	34 1	1165	2007	27 3	1233	2284	20 7	1528	2604	13 11	1756	2975
	59 15	1130	1955	52 11	1293	2224	45 7	1481	2535	38 3	1701	2894	31 1	1967	3311
	77 25	1248	2155	70 21	1429	2455	63 17	1640	2802	56 13	1866	3204	49 9	2173	3671
	95 35	1373	2389	88 31	1575	2701	81 27	1808	3087	74 23	2083	3635	67 19	2404	4086
18	23 5	728	1464	18 9	838	1883	9 13	981	1883	2 17	1108	2149	6 21	1279	2466
	41 5	813	1618	34 1	938	1842	27 3	1077	2102	20 7	1243	2402	13 11	1438	2760
	59 15	904	1793	52 11	1042	2046	45 7	1202	2338	38 3	1389	2674	31 1	1609	2957
	77 25	1003	1880	70 21	1196	2261	63 17	1336	2687	56 13	1548	2985	49 9	1793	3408
	95 35	1107	2180	88 31	1279	2482	81 27	1479	2956	74 23	1714	3277	67 19	1980	3768
30	23 5	588	1337	18 9	647	1823	9 13	751	1739	2 17	873	1888	6 21	1017	2278
	41 5	678	1490	34 1	728	1700	27 3	847	1944	20 7	986	2227	13 11	1149	2566
	59 15	702	1664	52 11	818	1880	45 7	949	2184	38 3	1107	2483	31 1	1292	2864
	77 25	782	1829	70 21	910	2094	63 17	1080	2401	56 13	1237	2756	49 9	1446	3174
	95 35	868	2017	88 31	1011	2311	81 27	1180	2683	74 23	1378	3052	67 19	1613	3518

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Section V
Performance

BEECHCRAFT Sundowner 180
(C23(M-1285 and After))

LANDING DISTANCE - HARD SURFACE

ASSOCIATED CONDITIONS

POWER IDLE
MIXTURE RICH
FLAPS 35°
RUNWAY LEVEL, DRY, HARD SURFACE
WEIGHT 2450 LBS

LANDING SPEEDS

AT 50 FT 66 KTS 76 MPH
TOUCHDOWN 61 KTS 70 MPH

WIND COMPONENT DOWN RUNWAY KNOTS	SEA LEVEL			2000 FT			4000 FT			6000 FT			8000 FT		
	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET	OAT °F °C	GROUND ROLL FEET	TOTAL OVER 50 FT OBSTACLE FEET
0	23 5	684	1408	18 9	692	1467	9 13	738	1532	2 17	780	1600	6 21	826	1672
	41 5	878	1448	34 1	719	1609	27 3	783	1576	20 7	810	1644	13 11	881	1724
	59 15	703	1484	52 11	748	1548	45 7	791	1617	38 3	840	1681	31 1	894	1776
	77 25	727	1521	70 21	771	1587	63 17	818	1658	56 13	871	1740	49 9	926	1827
	95 35	751	1568	88 31	788	1626	81 27	847	1703	74 23	901	1788	67 19	956	1882
18	23 5	498	1190	18 9	530	1243	9 13	587	1302	2 17	607	1366	6 21	660	1431
	41 5	518	1222	34 1	552	1280	27 3	582	1342	20 7	634	1407	13 11	679	1478
	59 15	530	1257	52 11	578	1317	45 7	617	1381	38 3	681	1448	31 1	708	1520
	77 25	540	1281	70 21	600	1354	63 17	642	1420	56 13	688	1488	49 9	737	1568
	95 35	582	1326	88 31	623	1380	81 27	667	1458	74 23	715	1530	67 19	788	1614
30	23 5	381	1005	18 9	390	1049	9 13	421	1095	2 17	456	1149	6 21	493	1211
	41 5	379	1012	34 1	408	1078	27 3	443	1127	20 7	479	1188	13 11	518	1252
	59 15	397	1060	52 11	429	1107	45 7	464	1163	38 3	502	1226	31 1	544	1293
	77 25	418	1088	70 21	449	1138	63 17	486	1200	56 13	526	1264	49 9	588	1334
	95 35	434	1114	88 31	469	1172	81 27	508	1235	74 23	550	1303	67 19	606	1378

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BEECHCRAFT Sundowner 180
(C23(M-1285 and After))

Section V
Performance

E. Climb Data

BEECHCRAFT Sundowner 180
C23 (M-1285 and After)

Section V
Performance

TIME, FUEL, AND DISTANCE TO CLIMB

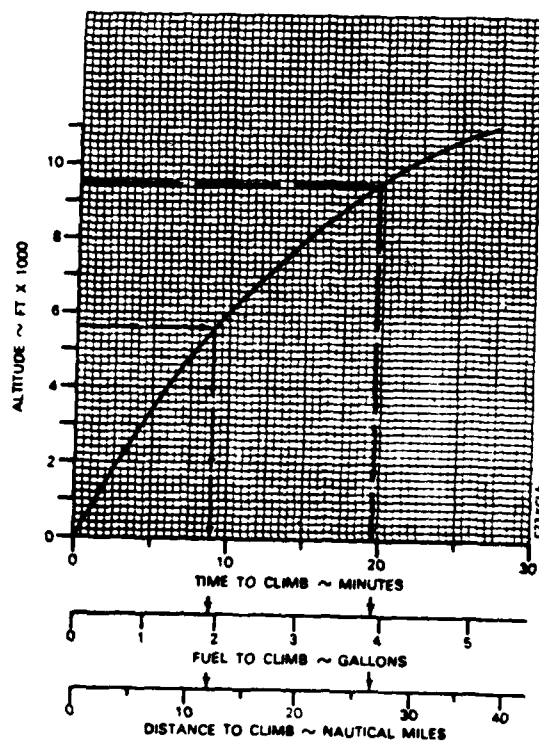
ASSOCIATED CONDITIONS

POWER FULL THROTTLE
MIXTURE LEAN TO MAXIMUM RPM
THEN ENRICH SLIGHTLY
FLAPS UP
WEIGHT 2450 LBS
STANDARD DAY

EXAMPLE

AIRPORT PRESSURE ALTITUDE 5550 FT
CRUISE ALTITUDE 8500 FT
TIME TO CLIMB 20.8 -
FUEL TO CLIMB 39.19 -
DIST TO CLIMB 27.12 -

75 KTS/80 MPH



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F. Cruise Data

Section V Performance

BEECHCRAFT Sundowner 180 C23 (M-1285 and After)

CRUISE PERFORMANCE STANDARD DAY

ALTITUDE FEET	POWER SETTINGS			TAS KTS/MPH	RANGE - N.M.	
	THROTTLE SETTINGS RPM	BHP	FUEL FLOW GAL/HR		INITIAL FUEL ONBOARD (USABLE)	
					27 GAL	87 GAL
2800	2700	88	13.2	124/143	278	485
	2600	73	10.4	113/130	318	538
	2300	60	8.2	100/118	385	688
3500	2700	86	12.8	123/142	272	471
	2600	71	10.1	112/128	319	561
	2300	59	8.1	98/113	384	612
4800	2700	84	12.5	123/141	288	484
	2600	70	9.8	111/127	328	553
	2300	59	8.0	98/113	354	607
5800	2698	82	12.0	122/140	295	498
	2500	68	9.6	110/127	333	562
	2300	58	7.9	97/112	358	600
6500	2688	79	11.6	121/139	308	512
	2500	67	9.4	109/126	337	572
	2300	58	7.8	96/110	349	582
7500	2680	77	11.2	120/138	308	521
	2500	66	9.2	108/125	340	576
	2300	57	7.9	96/109	348	587
8500	2670	75	10.8	119/136	318	533
	2500	65	9.0	108/124	341	582
	2300	57	7.8	94/108	341	579
9500	2662	73	10.5	117/135	318	542
	2500	64	8.8	107/123	298	685
	2300	57	7.8	93/106	334	571
10,500	2654	71	10.2	116/133	326	546
	2500	63	8.7	106/122	340	582
	2300	57	7.9	91/104	325	556

- NOTES: 1 Range includes start, taxi, climb, and a 45 minute reserve at 2300 RPM.
 2 Cruise performance is based on best power mixture. Lean to maximum RPM for a given throttle setting.
 3 It is recommended that use of tanks be alternated and that a fuel log be maintained showing time remaining in tanks.
 4 For a particular RPM the fuel flow and true airspeed will vary with temperature. To determine in flight fuel flow, enter the table at the nearest altitude corresponding to the density altitude, and the actual true airspeed.

ASSOCIATED CONDITIONS:

Pressure Altitude 4600 feet
 OAT 53°F
 Indicated Airspeed 111 kts

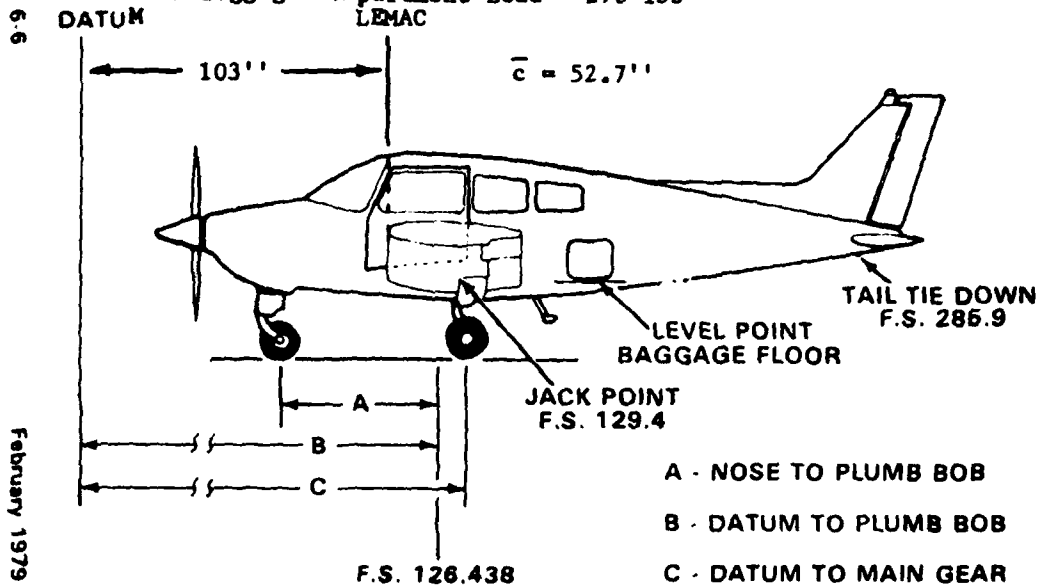
EXAMPLE:

Density Altitude 6300 feet
 Actual True Airspeed 121 kts
 Corresponding Altitude on Table 5880 feet
 Interpolating Factor (121 kts is 92% of the difference between 110 and 122 kts) 92%
 Fuel Flow (12.0 - 8.8 = 3.2 x .92 = 2.94)
 2.2 + 8.8 = 11.0

11.8 gal/hr

IV. Weight and Balance

Maximum Ramp Weight = 2455 lbs
 Maximum Take-off and Landing Weight = 2450 lbs
 Maximum Baggage Compartment Load = 270 lbs

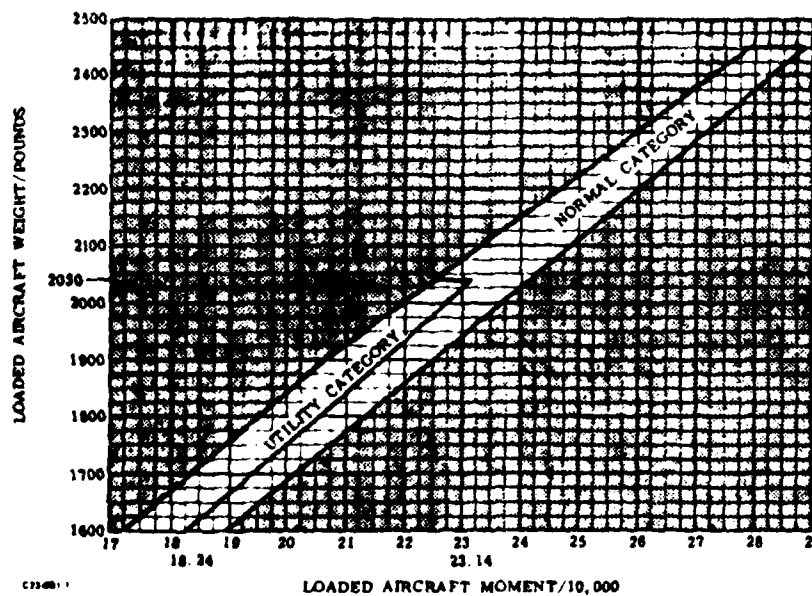


Section VI
 Weight and Balance List

BEECHCRAFT Sundowner 180
 C23 (M-1285 and After)

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February 1979



GROSS WEIGHT MOMENT LIMITS GRAPH

Section VI
 Weight and Balance List

BEECHCRAFT Sundowner 180
 C23 (M-1285 and After)

COMPUTING PROCEDURE

- 1 Record the Basic Empty Weight and Moment from the Basic Empty Weight and Balance form (or from the latest superseding form) under the Basic Empty Condition block. The moment must be divided by 100 to correspond to Useful Load Weights and Moments tables.
- 2 Record the weight and corresponding moment from the appropriate table of each of the useful load items (except fuel) to be carried in the airplane.
- 3 Total the weight column and moment column. The SUB-TOTAL is the Zero Fuel Condition.
- 4 Determine the weight and corresponding moment for the fuel loading to be used. This fuel loading includes fuel for the flight, plus that required for start, taxi, and take-off. Add the Fuel to Zero Fuel Condition to obtain the SUB-TOTAL Ramp Condition.
- 5 Subtract the fuel to be used for start, taxi, and take-off to arrive at the SUB-TOTAL Take-off Condition.
- 6 Subtract the weight and moment of the fuel in the incremental sequence in which it is to be used from the take-off weight and moment. The Zero Fuel Condition, the Take-Off Condition, and the Landing Condition moment must be within the minimum and maximum moments shown on the Moment Limit vs Weight graph for that weight. If the total moment is less than the minimum moment allowed, useful load items must be shifted aft or forward load items reduced. If the total moment is greater than the maximum moment allowed, useful load items must be shifted forward or aft and items reduced. If the quantity or location of load items is changed, the calculations must be revised and the moments rechecked.

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GROSS WEIGHT MOMENT LIMITS

(NORMAL CATEGORY)

Crane Weight 180	Maximum Height 180	Maximum Moment 180	Crane Weight 180	Maximum Height 180	Maximum Moment 180	Crane Weight 180	Maximum Height 180	Maximum Moment 180	Crane Weight 180	Maximum Height 180	Maximum Moment 180
1500	1617	1775	1800	2008	2246	2300	2746	2900	2900	2746	2900
1510	1628	1786	1910	2018	2256	2760	2760	2910	2910	2760	2910
1520	1639	1796	1920	2028	2266	2804	2771	2920	2920	2804	2920
1530	1649	1807	1930	2038	2276	2838	2783	2930	2930	2838	2930
1540	1660	1817	1940	2048	2286	2876	2795	2940	2940	2876	2940
1550	1671	1828	1950	2058	2296	2913	2807	2950	2950	2913	2950
1560	1682	1838	1960	2068	2306	2946	2819	2960	2960	2946	2960
1570	1692	1849	1970	2078	2316	2978	2831	2970	2970	2978	2970
1580	1703	1859	1980	2088	2326	2998	2842	2980	2980	2998	2980
1590	1714	1869	1990	2098	2336	3016	2854	2990	2990	3016	2990
1600	1725	1880	2000	2108	2346	3036	2866	3000	3000	3036	3000
1610	1736	1890	2010	2118	2356	3054	2878	3010	3010	3054	3010
1620	1746	1900	2020	2128	2366	3074	2890	3020	3020	3074	3020
1630	1757	1910	2030	2138	2376	3091	2902	3030	3030	3091	3030
1640	1768	1920	2040	2148	2386	3106	2914	3040	3040	3106	3040
1650	1779	1930	2050	2158	2396	3124	2926	3050	3050	3124	3050
1660	1789	1940	2060	2168	2406	3140	2938	3060	3060	3140	3060
1670	1799	1950	2070	2178	2416	3156	2950	3070	3070	3156	3070
1680	1810	1960	2080	2188	2426	3172	2962	3080	3080	3172	3080
1690	1821	1970	2090	2198	2436	3187	2974	3090	3090	3187	3090
1700	1832	1980	2100	2208	2446	3202	2986	3100	3100	3202	3100
1710	1843	1990	2110	2218	2456	3216	2998	3110	3110	3216	3110
1720	1854	2000	2120	2228	2466	3231	3010	3120	3120	3231	3120
1730	1864	2010	2130	2238	2476	3245	3022	3130	3130	3245	3130
1740	1875	2020	2140	2248	2486	3259	3034	3140	3140	3259	3140
1750	1886	2030	2150	2258	2496	3273	3046	3150	3150	3273	3150
1760	1897	2040	2160	2268	2506	3287	3058	3160	3160	3287	3160
1770	1907	2050	2170	2278	2516	3299	3070	3170	3170	3299	3170
1780	1918	2060	2180	2288	2526	3313	3082	3180	3180	3313	3180
1790	1928	2070	2190	2298	2536	3327	3094	3190	3190	3327	3190
1800	1939	2080	2200	2308	2546	3340	3106	3200	3200	3340	3200
1810	1950	2090	2210	2318	2556	3354	3118	3210	3210	3354	3210
1820	1961	2100	2220	2328	2566	3367	3130	3220	3220	3367	3220
1830	1972	2110	2230	2338	2576	3380	3142	3230	3230	3380	3230
1840	1983	2120	2240	2348	2586	3393	3154	3240	3240	3393	3240
1850	1994	2130	2250	2358	2596	3405	3166	3250	3250	3405	3250
1860	2005	2140	2260	2368	2606	3418	3178	3260	3260	3418	3260
1870	2016	2150	2270	2378	2616	3430	3190	3270	3270	3430	3270
1880	2027	2160	2280	2388	2626	3442	3202	3280	3280	3442	3280
1890	2038	2170	2290	2398	2636	3454	3214	3290	3290	3454	3290
1900	2049	2180	2300	2408	2646	3466	3226	3300	3300	3466	3300
1910	2060	2190	2310	2418	2656	3477	3238	3310	3310	3477	3310
1920	2071	2200	2320	2428	2666	3489	3250	3320	3320	3489	3320
1930	2082	2210	2330	2438	2676	3500	3262	3330	3330	3500	3330
1940	2093	2220	2340	2448	2686	3511	3274	3340	3340	3511	3340
1950	2104	2230	2350	2458	2696	3522	3286	3350	3350	3522	3350
1960	2115	2240	2360	2468	2706	3533	3298	3360	3360	3533	3360
1970	2126	2250	2370	2478	2716	3544	3310	3370	3370	3544	3370
1980	2137	2260	2380	2488	2726	3554	3322	3380	3380	3554	3380
1990	2148	2270	2390	2498	2736	3565	3334	3390	3390	3565	3390
2000	2159	2280	2400	2508	2746	3575	3346	3400	3400	3575	3400
2010	2170	2290	2410	2518	2756	3586	3358	3410	3410	3586	3410
2020	2181	2300	2420	2528	2766	3596	3370	3420	3420	3596	3420
2030	2192	2310	2430	2538	2776	3607	3382	3430	3430	3607	3430
2040	2203	2320	2440	2548	2786	3617	3394	3440	3440	3617	3440
2050	2214	2330	2450	2558	2796	3628	3406	3450	3450	3628	3450
2060	2225	2340	2460	2568	2806	3638	3418	3460	3460	3638	3460
2070	2236	2350	2470	2578	2816	3648	3430	3470	3470	3648	3470
2080	2247	2360	2480	2588	2826	3658	3442	3480	3480	3658	3480
2090	2258	2370	2490	2598	2836	3668	3454	3490	3490	3668	3490
2100	2269	2380	2500	2608	2846	3678	3466	3500	3500	3678	3500
2110	2280	2390	2510	2618	2856	3688	3478	3510	3510	3688	3510
2120	2291	2400	2520	2628	2866	3698	3490	3520	3520	3698	3520
2130	2302	2410	2530	2638	2876	3708	3502	3530	3530	3708	3530
2140	2313	2420	2540	2648	2886	3718	3514	3540	3540	3718	3540
2150	2324	2430	2550	2658	2896	3728	3526	3550	3550	3728	3550
2160	2335	2440	2560	2668	2906	3738	3538	3560	3560	3738	3560
2170	2346	2450	2570	2678	2916	3748	3550	3570	3570	3748	3570
2180	2357	2460	2580	2688	2926	3758	3562	3580	3580	3758	3580
2190	2368	2470	2590	2698	2936	3768	3574	3590	3590	3768	3590
2200	2379	2480	2600	2708	2946	3778	3586	3600	3600	3778	3600
2210	2390	2490	2610	2718	2956	3788	3598	3610	3610	3788	3610
2220	2401	2500	2620	2728	2966	3798	3610	3620	3620	3798	3620
2230	2412	2510	2630	2738	2976	3808	3622	3630	3630	3808	3630
2240	2423	2520	2640	2748	2986	3818	3634	3640	3640	3818	3640
2250	2434	2530	2650	2758	2996	3828	3646	3650	3650	3828	3650
2260	2445	2540	2660	2768	3006	3838	3658	3660	3660	3838	3660
2270	2456	2550	2670	2778	3016	3848	3670	3670	3670	3848	3670
2280	2467	2560	2680	2788	3026	3858	3682	3680	3680	3858	3680
2290	2478	2570	2690	2798	3036	3868	3694	3690	3690	3868	3690
2300	2489	2580	2700	2808	3046	3878	3706	3700	3700	3878	3700
2310	2500	2590	2710	2818	3056	3888	3718	3710	3710	3888	3710
2320	2511	2600	2720	2828	3066	3898	3730	3720	3720	3898	3720
2330	2522	2610	2730	2838	3076	3908	3742	3730	3730	3908	3730
2340	2533	2620	2740	2848	3086	3918	3754	3740	3740	3918	3740
2350	2544	2630	2750	2858	3096	3928	3766	3750	3750	3928	3750
2360	2555	2640	2760	2868	3106	3938	3778	3760	3760	3938	3760
2370	2566	2650	2770	2878	3116	3948	3790	3770	3770	3948	3770
2380	2577	2660	2780	2888	3126	3958	3802	3780	3780	3958	3780
2390	2588	2670	2790	2898	3136	3968	3814	3790	3790	3968	3790
2400	2599	2680	2800	2908	3146	3978	3826	3800	3800	3978	3800
2410	2610	2690	2810	2918	3156	3988	3838	3810	3810	3988	3810
2420	2621	2700	2820	2928	3166	3998	3850	3820	3820	3998	3820
2430	2632	2710	2830	2938	3176	4008	3862	3830	3830	4008	3830
2440	2643	2720	2840	2948	3186	4018	3874	3840	3840	4018	3840
2450	2654	2730	2850	2958	3196	4028	3886	3850	3850	4028	3850
2460	2665	2740	2860	2968	3206	4038	3898	3860	3860	4038	3860
2470	2676	2750	2870	2978	3216	4048	3910	3870	3870	4048	3870
2480	2687	2760	2880	2988	3226	4058	3922	3880	3880	4058	3880
2490	2698	2770	2890	2998	3236	4068	3934	3890	3890	4068	3890
2500	2709	2780	2900	3008	3246	4078	3946	3900	3900	4078	3900
2510	2720	2790	2910	3018	3256	4088	3958	3910	3910	4088	3910
2520	2731	2800	2920	3028	3266	4098	3970	3920	3920	4098	3920
2530	2742	2810	2930	3038	3276	4108	3982	3930	3930	4108	3930
2540	2753	2820	2940	3048	3286	4118	3994	3940	3940	4118	3940
2550	2764	2830	2950	3058	3296	4128	4006	3950	3950	4128	3950
2560	2775	2840	2960	3068	3306	4138	4018	3960	3960	4138	3960
2570	2786	2850	2970	3078	3316	4148	4030	3970	3970	4148	3970
2580	2797	2860	2980	3088	3326	4158	4042	3980	3980	4158	3980
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BEECHCRAFT Sundowner 180 Section VI
C23 (M-1285 and After) Wt and Bal/Equip List

WEIGHT AND BALANCE LOADING FORM

MODEL _____ DATE _____

SERIAL NO. _____ REG NO. NXXX

ITEM	WEIGHT	MOM/100
1. BASIC EMPTY CONDITION		
2. FRONT SEAT OCCUPANTS		
3. 3rd & 4th SEAT OCCUPANTS		
4. BAGGAGE OR CARGO		
5. SUB TOTAL ZERO FUEL CONDITION		
6. FUEL LOADING (GAL)		
7. SUB TOTAL RAMP CONDITION		
8. *LESS FUEL FOR START, TAXI, AND TAKE-OFF		
9. SUB TOTAL TAKE-OFF CONDITION		
10. LESS FUEL TO DESTINATION (GAL)		
11. LANDING CONDITION		

*Fuel for start, taxi and take-off is normally 5 lbs at an average mom/100 of 6.

REG NO. _____ BASIC EMPTY
CONDITION _____ MOM/100 _____

N6014M 1590.0 lbs 1778
N60171 1525.0 lbs 1688
N18325 1580.5 lbs 1792

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Section VI BEECHCRAFT Sundowner 180
Wt and Bal/Equip List C23 (M-1285 and After)

The following Sample Loading chart is presented to depict the sample method of computing a load. Weights used DO NOT reflect an actual airplane loading.

WEIGHT AND BALANCE LOADING FORM

MODEL C23 DATE _____

SERIAL NO. M-XXXX REG NO. NXXX

ITEM	WEIGHT	MOM/100
1. BASIC EMPTY CONDITION	1500	1650
2. FRONT SEAT OCCUPANTS	340	374
3. 3rd & 4th SEAT OCCUPANTS	340	482
4. BAGGAGE OR CARGO	40	67
5. SUB TOTAL ZERO FUEL CONDITION	2220	2573
6. FUEL LOADING (37 GAL)	222	259
7. SUB TOTAL RAMP CONDITION	2442	2832
8. *LESS FUEL TAXI, AND TAKE-OFF	.5	.6
9. SUB TOTAL TAKE-OFF CONDITION	2437	2826
10. LESS FUEL TO DESTINATION (25 GAL)	.150	.176
11. LANDING CONDITION	2287	2650

*Fuel for start, taxi and take-off is normally 5 lbs at an average mom/100 of 6

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USEFUL LOAD WEIGHTS AND MOMENTS

OCCUPANTS

WEIGHT	FRONT SEATS			3RD AND 4TH SEATS	
	*FWD POS.		*AFT POS.	BENCH SEAT	SPLIT SEAT
	††ARM **104	†ARM **105	ARM **112	ARM **142	ARM **144
	MOM 100	MOM 100	MOM 100	MOM 100	MOM 100
120	125	126	134	170	173
130	135	137	146	185	187
140	146	147	157	199	202
150	156	158	168	213	216
160	166	168	179	227	230
170	177	179	190	241	245
180	187	189	202	256	259
190	198	200	213	270	274
200	208	210	224	284	288

*Effective M-1285 thru M-2006

††Effective M-2007 and after

*Reclining seat with back in full-up position

**Values computed from a C.G. criterion based on a 170 pound male. Differences in physical characteristics can cause variation in center of gravity location.

USEFUL LOAD WEIGHTS AND MOMENTS

OIL
(Included in Basic Empty Weight)

ARM 48		
QTS	WT	MOMENT/100
8	15	7

USABLE FUEL

ARM 117		
GALLONS	WEIGHT	MOMENT/100
5	30	35
10	60	70
15	90	105
20	120	140
22	132	154
25	150	176
27	162	189
30	180	211
32	192	225
35	210	246
37	222	259
40	240	281
45	270	316
50	300	351
52	312	365
55	330	386
57	342	400
58	348	407

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USEFUL LOAD WEIGHTS AND MOMENTS

BAGGAGE

ARM 167	
WEIGHT	MOMENT 100
10	17
20	33
30	50
40	67
50	84
60	100
70	117
80	134
90	150
100	167
110	184
120	200
130	217
140	234

APPENDIX B

Test Plan Sierra C24R Limited Performance Evaluation

UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

DEPARTMENT OF AERONAUTICS

AERO 495

TEST PLAN

SIERRA C24R LIMITED PERFORMANCE EVALUATION

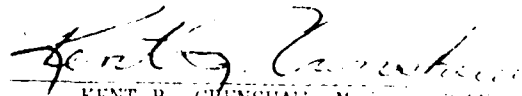
JUNE 1982

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TEST PLAN
DEPARTMENT OF AERONAUTICS
SIERRA C24R LIMITED PERFORMANCE EVALUATION

JUNE 1982

This test plan has been prepared by:



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TEST PLAN
DEPARTMENT OF AERONAUTICS
SIERRA C24R LIMITED PERFORMANCE EVALUATION

INTRODUCTION

A limited performance evaluation of the Beech Sierra C24R will be conducted at the U. S. Air Force Academy by Department of Aeronautics (DEAN) faculty and the students enrolled in Aero 495. Flight testing will be conducted during the spring semester from the fifth to tenth week of classes. Results of the evaluation will be presented in a formal oral report given by each of two student test teams.

OBJECTIVES

The objectives of this evaluation are to determine the Sierra C24R's general performance characteristics and to compare them to the contractor's Flight Manual. In addition, certain contractual guarantees are verified. Specific objectives follow.

A. Takeoff Performance

- determine takeoff power ground roll using the Flight Manual takeoff procedure
- verify the takeoff performance predicted in the contractor's Flight Manual

B. Climb Performance

- determine the full throttle maximum rate of climb
- determine the full throttle best angle of climb
- verify the climb performance predicted in the contractor's Flight Manual

C. Level Turn Performance

- determine the level sustained turn performance in cruise power at 2,700 rpm
- determine the speed for optimum sustained turn performance at the test altitude

D. Cruise Performance

- determine the airspeeds and rpm for maximum range and maximum endurance as derived from test data
- determine the aircraft drag polar
- compare test results with the contractor's Flight Manual

E. Descent Performance

- determine the propeller windmilling best no wind glide ratio
- determine the best glide speed and minimum sink speed with propeller windmilling
- compare test results with the contractor's Flight Manual maximum glide configuration of 91 knots

F. Contractual Guarantees

- maximum speed at sea level-142 knots
- cruise speed at 75% power, 10,000 feet-137 knots
- range with 45 minute reserve at 75% power at 10,000 feet-646 nautical miles
- rate of climb at sea level-927 fpm
- service ceiling-15,385 feet

AUTHORITY

This test program will be conducted by Department of Aeronautics faculty and students as an integral part of the curriculum for Aero 495, a course in flight test techniques. The program has the approval of the Superintendent, the Dean of the Faculty, the Head of the Department of Aeronautics, and the Director of Flight Operations of Hedrick Beechcraft Inc.

TEST TEAM ORGANIZATION

Test team organization shown in Figure 1 will consist of two DEAN faculty pilots and two student flight test engineer teams. Each test team will be assigned to 11, with one faculty pilot. A Test Director for each team will be appointed to coordinate the entire evaluation effort. He will in turn appoint individuals to be in charge of each test area (i.e., data monitors). It will be the data monitor's responsibility to specify the tests to be flown in support of his test area. Test areas to be assigned are takeoff, climb, turn, cruise and descent performance.

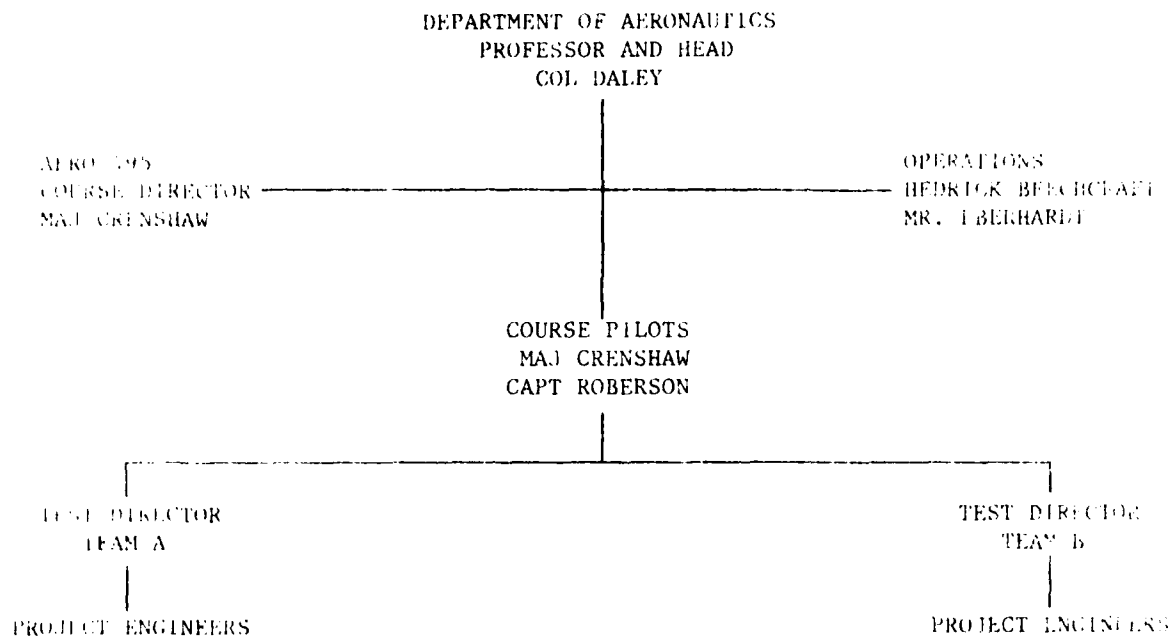


Figure 1. Organization Chart

SCOPE/SCHEDULE

The evaluation will consist of sorties as specified in Table 1.

Table 1. Data Sorties

Test	Sorties Per Test Team	Flight Time Per Sortie
Flight #1 Takeoff Performance Cruise Performance Turn Performance	2.5	1.0
Flight #2 Takeoff Performance Climbs and Descents	2.5	1.0
*Total	5	

*One sortie will be shared by both test teams.

Flight #1 and #2 are scheduled as shown on the Integrated Academics and Flying Schedule for Aero 495. Mission time will not exceed 1.0 hour.

LIMITATIONS

The following limitations will be observed during this evaluation.

A. The aircraft will be operated in accordance with the Airplane Flight Manual, FAR Part 91 and all Beech Aero Club Operating Instructions.

B. All data sorties will be flown with one DFAN faculty pilot and two cadets.

C. Testing will only be accomplished under VFR daytime conditions at 10,000 ft MSL and below.

D. All testing will be accomplished within the local flying area of Colorado Springs.

TEST AIRCRAFT DESCRIPTION

The Beechcraft Sierra C24R, manufactured by Beech Aircraft Corporation, is a six-place, retractable, general aviation aircraft powered by one fuel-injected, 4-cylinder, 200 HP Avco Lycoming engine. The propeller is a Hartzell constant-speed, two-blade, aluminum-alloy prop with spinner. See Figure 2 for general dimensions and Table 2 for Aircraft Limitations.

BEECHCRAFT
Sierra C24R

$S = 146.11 \text{ ft}^2$
 $AR = 7.5$
 $c = 52.7 \text{ in}$

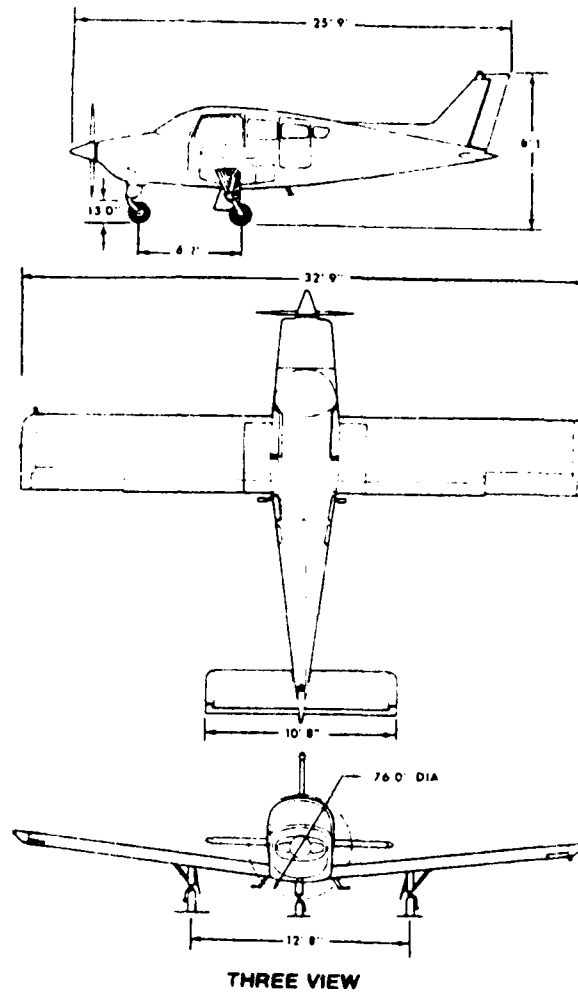


Figure 2. Three View of Sierra C24R
(Reference 1)

Table 2. Aircraft Limitations

	IAS Knots/mph
Never Exceed Speed (V_{NE})	168/193
Maximum Maneuvering Speed (V_A)	125/144
Maximum Cruising Speed in Turbulent Air (V_C)	143/165
1G Stall Speed Gear and Flaps Up (2,600 lbs) (power idle)	65/75
Maximum Ramp Weight	2,785 lbs
Maximum Takeoff Weight	2,750 lbs
Maximum Landing Weight	2,750 lbs
Flight Maneuvering Load Factor Flaps Up	+3.8 to -1.9G
Flight Maneuvering Load Factor Flaps Down	+1.9G
Maneuver, Bank Angles No More Than 60°	
Service Ceiling	15,385 feet
Test Plan Ceiling	10,000 feet

FLIGHT TEST INSTRUMENTATION

All test data will be hand recorded using standard cockpit instrumentation. The only exceptions are the use of an accelerometer, a stopwatch and a cockpit tape recorder.

WEIGHT AND BALANCE

Detailed weight and balance records for each aircraft are available at Cessna Aircraft. Prior to every data mission, student test engineers will calculate aircraft weight and balance data for both takeoff and landing.

TEST DESCRIPTION PROCEDURES

Unless otherwise noted, all performance tests will be performed with engine operating, landing gear and wing flaps retracted. All data will be hand and voice recorded, and manually reduced to standard aircraft weight and atmospheric conditions. Specific test techniques for each area will be covered in classroom lectures and handouts from references 2, 3, and 4.

A. Takeoff Performance

The takeoff ground roll will be determined and hand recorded for each bottle.

All takeoffs will be made with 15° of flaps in accordance with the Sierra C24R Airplane Flight Manual.

B. Climb Performance

Climb data at different airspeeds will be obtained using sawtooth climbs. Data will be obtained at 2,700 rpm with mixture adjusted for best power at test altitudes of 8,000, 8,500, 9,000 and 9,500 feet. Engine operating limitations as specified in the Flight Manual will be followed.

C. Level Turn Performance

Turn performance for the Sierra will be determined from stabilized turns at various altitudes and airspeeds. Data will be obtained at 2,700 rpm, or full throttle, between 7,000 and 10,000 feet. Engine operating limitations as described in the Flight Manual will be followed.

D. Cruise Performance

Cruise performance will be evaluated using the P_{1W} versus V_{1W} test technique covered in references 2 and 4. Using the backside trim shot technique, the aircraft will be stabilized at several altitude and airspeed combinations. Data will be obtained at altitudes between 7,000 and 10,000 feet.

E. Descent Performance

Descent performance will be determined at various airspeeds at test altitudes of 8,000, 8,500, 9,000 and 9,500 feet. The aircraft will be operated with the throttle at idle and propeller at high pitch for gathering descent data. The Flight Manual restriction concerning prolonged idle settings will be observed.

TRAINING

Both DEAN faculty pilots will have at least an FAA commercial pilot rating and be current in the Beech Sierra C24R in accordance with FAA and Hedrick Beechcraft Aero Club standards.

All cadets enrolled in Aero 495 will participate in the flying portion of the course as passengers only and will receive appropriate aircraft orientation and safety instruction. All the performance flight test techniques required to gather test data will be covered during classroom lectures prior to the flights for which they will be used.

CREW DUTIES

A. Pilot

1. Check local flying weather.
2. Brief students on mission profile, and ground and in-flight duties.
3. Check maintenance status of aircraft and perform pre-flight.
4. Provide a stopwatch.
5. Provide the tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
6. Act as pilot in command of the aircraft and occupy the left front seat at all times.

B. Students

1. Bring data cards and a clipboard.
2. Complete aircraft weight and balance form.
3. Compute takeoff data using temperature and pressure altitude provided by the pilot.
4. Provide cassette tape player for each flight. (optional)
5. Record tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
6. Cadets will be assigned to two man teams for purposes of taking flight test data. Flight crew duties will be rotated each flight. Along with the pilot who will be primarily concerned with precisely flying the aircraft, both cadets will act as lookouts and notify the pilot immediately of an aircraft sighted. The cadet in the right front seat will act as data observer and timekeeper and the cadet in the rear seat will act as data recorder.

SAFETY

Flight personnel will adhere to the following while on the flightline and in and around the aircraft:

- a. Smoking is prohibited in or near the aircraft.
- b. Seat belts will be worn at all times.
- c. Flight personnel will be seated in the aircraft prior to engine start and will remain seated until the engine is stopped.
- d. Remain clear of the propeller area at all times.
- e. Do not stand, walk, or lean on the aircraft except in designated areas.

- d. Do not open aircraft windows or doors in flight.
- e. Advise the pilot immediately upon observing another aircraft.
- f. Do not manipulate the aircraft flight controls or engine controls unless told to do so by the pilot.
- g. Advise the pilot of impending airsickness. Use the bag provided, your hat, your shoe, anything except the floor of the aircraft.
- h. Stay clear of taxiing aircraft and other flightline vehicles.

COMMAND AND CONTROL

All testing to be accomplished will be for academic purposes only and will be performed within the restrictions of the Flight Manual, Part 91 of the FAR's, Redick Beecheritt Aero Club Rules and the limitations imposed by this test plan.

All information with respect to this test plan is unclassified.

TEST PLAN AMENDMENTS

An amendment to this test plan is required if the flight test envelope is expanded or if any limitations in the test plan are made less restrictive. An amendment to the test plan must be reviewed and approved by the same authority who approved the basic plan.

REFERENCES

1. Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for the Beechcraft Sierra C24R, Beech Aircraft Corporation, Wichita, Kansas, November 1980.
2. Kimberlin, Ralph D., Performance Flight Testing Lecture Notes, The University of Tennessee Space Institute, Tullahoma, Tennessee, 1982.
3. Performance Theory and Flight Test Techniques, USAF Test Pilot School, Edwards AFB, California, FTC-TIH-79-1, 1 August 1979.
4. Roberts, Sean C., Light Aircraft Performance for Test Pilots and Flight Test Engineers, Flight Research, Inc., Mojave, California, 1980.

APPENDIX C

Flight Test Planning Guide Sierra C24R Limited Performance Evaluation

AERO 495 FLIGHT TEST TECHNIQUES

FLIGHT TEST PLANNING GUIDE

SIERRA C24R LIMITED PERFORMANCE EVALUATION

MAJ CRENSHAW

JUNE 1982

C-2

CONTENTS

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Flight 1 - Cruise and Turn Performance	1
Flight 2 - Climb and Descent Performance	9
References	17

FLIGHT 1

Cruise and Turn Performance

I. OBJECTIVES

A. Determine power required as a function of flight speed in order to estimate various aircraft performance parameters.

B. Determine the sustained level turn performance as a function of flight speed and estimate optimum sustained maneuvering speed at test altitude.

II. AIRCRAFT

Beechcraft Sierra C24R

III. LIMITATIONS

As specified in the test plan.

IV. MISSION EVENTS

A. Pilot

1. Lineup abeam a runway light prior to brake release for takeoff. Make Flight Manual 15° flap takeoff.

2. Stabilize the aircraft in level flight at a selected test altitude between 7,000 and 10,000 feet.

3. Trim at V_{max} airspeed at 2,700 rpm/75% MCP, 2,500 rpm/75% MCP, 2,400 rpm/65% MCP and 2,400 rpm/55% MCP. Use the Flight Manual leaning procedure for fuel flow and cruise table for manifold pressure.

4. Trim at different flight velocities at a selected rpm of 2,700, 2,600, 2,500 or 2,400. Do this by varying manifold pressure in 1 inch Hg increments. Do not go below 15" Hg or above 28.7" Hg for any rpm setting. Again, use the Flight Manual leaning procedure for fuel flow.

5. Perform stabilized turns starting from the wings level V_{max} airspeed at 2,700 rpm/75% MCP. Stabilize at bank angles up to and including 60° in 10° increments.

6. Make normal full stop landing.

B. Students

1. Record takeoff ground roll.

2. For each stabilized wings level and turn point, record IAS, pressure altitude, OAT, RPM, MAP, fuel flow and tach time. Also record for turns the time through 360 degrees.

3. Record post flight aircraft tach time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce data using the attached data reduction sheets. Use a standard weight of 2,750 lbs where indicated.

B. Plot

1. BHP_{iw} V_{iw} versus V_{iw}^4 (knots)
2. BHP_{iw} versus V_{iw} (knots)
3. SAR versus V_{iw} (knots)
4. SE versus V_{iw} (knots)
5. C_L^2 versus C_D
6. C_L versus C_D
7. n_t versus VCAS (knots)
8. R_t versus VCAS (knots)
9. ω_t versus VCAS (knots)

C. Determine

1. Sea level maximum range airspeed (knots).
2. Estimated maximum range with 57 gallons of fuel at the test altitude with a 45 minute reserve.
3. Sea level maximum endurance airspeed (knots).
4. Airspeed for maximum range glide, power off (knots).
5. Maximum power-off glide ratio
6. Aircraft efficiency factor.
7. Aircraft drag polar.
8. Airspeed for optimum sustained turn performance at the test altitude (knots).

D. Tabulate the actual true airspeeds versus the Flight Manual predicted true airspeeds from the "Cruise Power Settings" table for 2,700 rpm/75% MCP, 2,500 rpm/75% MCP, 2,400 rpm/65% MCP and 2,400 rpm/55% MCP. Use a standard weight of 2,600 pounds.

- E. Complete the "Initial Flight Test Report".
- F. Complete a set of sample calculations.
- G. Turn in "Initial Flight Test Report" with results, recorded data, data reduction sheets, sample calculations, and plots.

DATE _____

INSTRUCTOR

STUDENTS

AIRCRAFT NU.

PRE-FLIGHT TACH TIME

POST-FLIGHT TACH TIME

TAKEOFF V:

TAKEOFF DATA: FIELD ELEVATION-6,172 FEET

ALTIMETER

WINDS

PRESS. ALT.

TEMP

GD ROLL (P)

GD ROLL (A)

TAKEOFF V:

[illegible]

[illegible]

STANDARD WEIGHT, $W_s = 2,750$ LB.

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓
Vi (Kts)	Ve (Kts)	Hi (ft.)	Hc (ft.)	Wt (lb.)	BHPT (H.P.)	Ti °C	Ta °K	Wf lb/hr.	δ p/po	σ p/po	Viw (Kts)	BHPiw (HP)	Vtrue (Kts)	SAR	Cp	J	η	CL	Cd	SE	BHPiw X Viw	V ⁴ iw

1. V_i (Kts.) indicated airspeed
2. V_c (Kts.) $\approx V_e$ (Kts.) p. 5-10 F.M.
3. H_i (ft.) indicated pressure altitude
4. H_c (ft.) calibrated pressure altitude, p. 5-12 F.M.
5. Test Weight, Wt. = Basic Empty Weight + crew + fuel
6. BHP_t Test brake H.P. obtained from engine charts
7. T_i Indicated outside air temperature
8. T_a Outside air temperature, °Kelvin
9. \dot{W}_f fuel flow = $\frac{6 \text{ lb} \times \text{gal}}{\text{gal} \times \text{hr}} = \text{lb./hr.}$
10. δ , pressure ratio, obtained directly from altitude charts & H_c
11. σ , density ratio = $\frac{\delta}{T_a \times 288.15^{1/2}} = \frac{10 \times 288.15}{8}$
12. $V_{iw} = V_e \left(\frac{W_s}{W_t} \right)^{1/2} = 2 \times \left(\frac{W_s}{5} \right)^{1/2}$
13. $BHP_{iw} = BHP_t \left(\frac{W_s}{W_t} \right)^{3/2} (\sigma)^{1/2} = 6 \times \left(\frac{W_s}{5} \right)^{3/2} \times (11)^{1/2}$
14. $V_{true} Kts = \frac{V_e}{\sqrt{\sigma}} = \frac{2}{\sqrt{.}} \times (11)^{1/2}$
15. SAR, Specific Air Range = $\frac{V_{true}}{\dot{W}_f} = \frac{W_t}{W_s} = (12 \div 9) \text{ (NAM/lb)} \times \frac{5}{W_s}$
16. C_p , Propeller Power Coefficient from charts knowing BHP_t , RPM & σ .
17. J, Propeller Advance Ratio $\frac{V}{\text{RPM} \times \sqrt{\sigma}}$ from charts knowing V_e ,

CRUISE PERFORMANCE DATA REDUCTION

(CONTINUED)

18. η , Propeller Efficiency, from charts knowing C_p & J.

$$19. C_L, \text{ Aircraft lift coefficient} = \frac{W_t}{\frac{1}{2} \rho_o (V_e \times 1.689)^2 S}$$

$$20. C_D, \text{ Aircraft drag coefficient} = \left(\frac{550 \eta \text{ BHP}_t}{V_{\text{true}} \times 1.689} \right) \left(\frac{1}{\left(\frac{1}{2} \rho_o (V_e \times 1.689)^2 S \right)} \right)$$

$$21. \text{ SE, Specific Endurance} = \frac{1}{W_f} \left(\frac{W_t}{W_s} \right)^{3/2} = \frac{1}{(9)} \left(\frac{5}{W_s} \right)^{3/2} \text{ hr/lb}$$

STANDARD WEIGHT, $W_S = 2,750$ LB.[illegible]

1. V_i (Kts) indicated airspeed
2. V_c (Kts) $\approx V_e$ (Kts) equivalent airspeed, p. 5-10 F.M.
3. H_i (ft) indicated pressure altitude
4. H_c (ft) calibrated pressure altitude, p. 5-12 F.M.
5. T_i Indicated outside air temperature
6. T_a Outside air temperature, °Kelvin
7. σ , pressure ratio, obtained from altitude charts and H_c
8. ρ , density ratio = $\frac{\sigma}{T_a} \times \frac{288.15}{288.15} = \frac{\textcircled{7} \times 288.15}{\textcircled{6}}$

FLIGHT 2

Climb and Descent Performance

I. OBJECTIVES

A. Determine maximum rate of climb and maximum angle of climb and respective airspeeds at which they occur.

B. Determine best glide speed, best no wind glide ratio and minimum sink rate and speed with propeller windmilling. Produce a propeller windmilling drag polar for the aircraft.

II. AIRCRAFT

Beechcraft Sierra C24R

III. LIMITATIONS

As specified in the Test Plan.

IV. MISSION EVENTS

A. Pilot

1. Lineup abeam a runway light prior to brake release for takeoff. Make normal 15° flap takeoff.

2. For climbs, set RPM at 2,700 and adjust mixture for best power. Stabilize the aircraft in a steady climb at airspeeds of 70, 80, 90, 100 and 110 knots on a heading perpendicular to the wind direction. At 500 feet below the test altitude, set full throttle and climb to 500 feet above the test altitude. Also establish level flight speed at the test altitude using climb power. Test altitudes are 8,000, 8,500, 9,000 and 9,500 feet.

3. For descents, fly power-off glides (throttle idle, propeller high pitch) in 10 knot increments from 120 knots to 80 knots from 500 feet above to 500 feet below the test altitude. Test altitudes are 8,000, 8,500, 9,000 and 9,500 feet.

4. Make normal full stop landing.

B. Students

1. Record takeoff ground roll.

2. During climbs, record the time to climb through 1,000 feet with a stopwatch. Also record tach time and OAT at 500 feet below the test altitude, at the test altitude, and 500 feet above the test altitude. Record RPM and MAP at the test altitude. Record the climb rate indicated on the Vertical Velocity Indicator (VVI) and elapsed time at each 100 feet. Note the maximum velocity at climb power in level flight at the test altitude.

3. During glides, time the glide through 1,000 feet of descent with a stopwatch. Record tach time and OAT at 500 feet above the test altitude, at the test altitude and at 500 feet below the test altitude. Also record VVI and elapsed time every 100 feet.

4. Record post flight aircraft tachometer time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce data using the attached data reduction sheets. Use a standard weight of 2,750 lbs where indicated.

B. Plot

1. $(R/C)_T$ versus IAS (knots)
 2. $(R/C)_S$ versus V_{iw} (knots)
 3. L/D versus V_{iw} (knots)
 4. C_D versus C_L^2 (drag polar)
 5. Sink rate (ft/min) versus V_{iw} (knots)
- } for descents

C. Determine

1. Airspeed for best rate of climb and for best angle of climb on both plots of $(R/C)_T$ and $(R/C)_S$.

2. Airspeed for max glide range and minimum sink.

D. Complete the "Initial Flight Test Report".

E. Complete a set of sample calculations.

F. Turn in "Initial Flight Test Report" with results, recorded data, data reduction sheets, sample calculations and plots.

CLIMB DATA

WIND DIRECTION (DEG) _____

WIND SPEED (KTS) _____

WINDS _____

PRESS. ALT. _____

TIME _____

GR ROLL (P) _____

GR ROLL (AO) _____

CARLOFF V₁ _____

WIND DIRECTION (DEG) _____

WIND SPEED (KTS) _____

TIME _____

GR ROLL (P) _____

GR ROLL (AO) _____

CARLOFF V₁ _____

CLIMB DATA

FLY NO.	TIME	OAT	TOTAL TIME		VVI (FPM) ELAPSED TIME	
			TIME	SECS	TIME	SECS
1		-500 ALT			-400	+500
2					-300	+400
3					-200	+300
4					-100	+200
5					ALT	+100
6						
7						
8						
9						
10						

- C-16

17. \dot{V} , Propeller Efficiency η_p , Wing Area S

18. \dot{V} , \dot{W}_p , \dot{W}_t and Propulsion Efficiency Correction to Rate of Climb

$$\left(\frac{dH}{dt}\right)_{\text{corr}} = \frac{\dot{V}}{W_S} \left[\dot{W}_H + \dot{W}_P \left(1 - \frac{P_S}{P_t}\right) \right] \times 550$$

$$\left(\frac{dH}{dt}\right)_{\text{corr}} = \frac{\dot{V}}{W_S} \left[\textcircled{9} + \textcircled{11} \left(1 - \frac{1}{\textcircled{8}}\right) \right] \times 550$$

19. $\left(\frac{dH}{dt}\right)_{\text{corr}} = \left(\frac{dH}{dt}\right)_L + \left(\frac{dH}{dt}\right) = \textcircled{9} + \textcircled{18}$

20. Weight Correction to Rate of Climb

$$\left(\frac{dH}{dt}\right)_{\text{corr}} = \left(\frac{dH}{dt}\right)_P \frac{W_S}{W_t} \times 60 = \textcircled{19} \times \sqrt{\textcircled{5}} \quad (\text{FPM})$$

$$\sqrt{\frac{d^2 p}{d t^2}} = \frac{d}{d t} \sqrt{\frac{d p}{d t}}$$

Weight Correction to Rate of Descent

$$\frac{(H^2 \pi^2)}{(H^2 \pi^2)} = \frac{(H^2 \pi^2)}{(H^2 \pi^2)} \times \frac{(H^2 \pi^2)}{(H^2 \pi^2)}$$

b. pressure ratio from altitude charts for H_0

100

$$\text{Value}(K_5) = \frac{1}{\frac{1}{2} + \frac{1}{2}} = 1$$

$$C_2 = \frac{V_2}{V_1} \times (V_2 \times 1.386) \times \frac{1}{2} = \frac{2}{3} \times (2 \times 1.386) \times \frac{1}{2}$$

Indicated airspeed

1. $V_{\text{max}}(K_{\text{ts}}) = 1.2 \text{ (Kts)}$, p. 5-10 F.V.

: ft.) indicated pressure altitude

 H_0 (ft.) corrected pressure altitude, 1,500-12,000 F.M.Test Weight, w_T = Basic Empty Weight + crew + fuel

$$v_{iw} = v_0 \left(\frac{1}{1 + \frac{1}{2} \frac{v_0^2}{c^2}} \right)$$

(pH) versus time. This is meant to illustrate the effect of the pH on the rate of the reaction.

$\frac{1}{Jt}$ is lost altitude. $\frac{1}{Jt}$ is $\frac{1}{Jt}$.

Abstract Test Temperature

15. Abs. alt. ft. Temperature at test altitude

REFERENCES

1. Flight Test Engineering Handbook, Air Force Flight Test Center, Edwards AFB, California, TR 6273, January 1965.
2. Roberts, Sean C., *Light Aircraft Performance for Test Pilots and Flight Test Engineers*, Flight Research, Inc., Mojave, California, 1980.
3. Trefft, V. V., *1A 415 Elements of Flight Test Engineering*, United States Naval Academy, Annapolis, Maryland, 1981.

INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE

2. SERIAL NUMBER

CONDITIONS RELATIVE TO TEST

a. PILOT:	e. CONFIGURATION:	i. FUEL LOAD:
b. OBSERVERS:	f. INSTRUMENTATION:	j. SURFACE WIND:
c. TAKE OFF TIME/T.O. TIME:	g. START UP GR WT:	k. WEATHER:
d. TESTS PERFORMED	h. START UP C.G.:	l. GROUND BLOCK:

3. RESULTS OF TESTS (Continue on reverse side if needed)

4. REMARKS (Continue on reverse side if needed)

5. COMMENTS (Continue on reverse side if needed)

APPENDIX D

Sample Performance Data Records, Data Reduction and Plots

Contents

	<u>Page</u>
*Flight 1 - Cruise and Turn Performance	D-3
*Flight 2 - Climb and Descent Performance	D-15
* Note that the data records for both of these flights show only a sample of the actual data taken on the dates indicated. As the plots derived from both flights indicate, several more data runs were performed.	

• •

•

• • •

May 28, 1952

30.36

010/6 knots

5700 ft

410 F

270091 1600 ft

145057

QUESTIONS: Test Altitude = 10,000 ft TAKEOFF VI 66 knots
pressure altitude

11-4

2. Air Drag Coefficient
 3. Air Drag Coefficient

18. 5, Propeller Efficiency, true starts knowing C_p & C_d .

19. 61, Air rate lift coefficient = $\frac{C_L}{C_D}$
 $C_D(V_C \times 1.689)^2 \times S$

20. 70, Air rate drag coefficient = $\left(\frac{550 \times \text{BHP}_t}{V_C \times 1.689} \right) \left(\frac{1}{V_C \times 1.689} \right)$
 $\left(\frac{1}{V_C \times 1.689} \right) \left(\frac{1}{V_C \times 1.689} \right) \left(\frac{1}{V_C \times 1.689} \right)$

21. 81, specific Endurance = $\frac{1}{C_D} \left(\frac{C_L}{C_D} \right)^{3/2} = \frac{1}{C_D} \left(\frac{C_L}{C_D} \right)^{3/2}$ hr/lb

AD-A131 457

AIRBORNE LABORATORY MEASUREMENT OF AIRCRAFT PERFORMANCE
AND STABILITY AND CONTROL FOR LIGHT AIRCRAFT SUPPLEMENT
(U) AIR FORCE ACADEMY CO K R CRENSHAW 24 JUN 83
USAF-A-TN-83-3

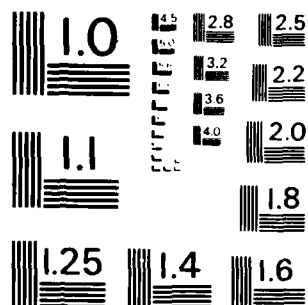
2/2

UNCLASSIFIED

F/G 14/2

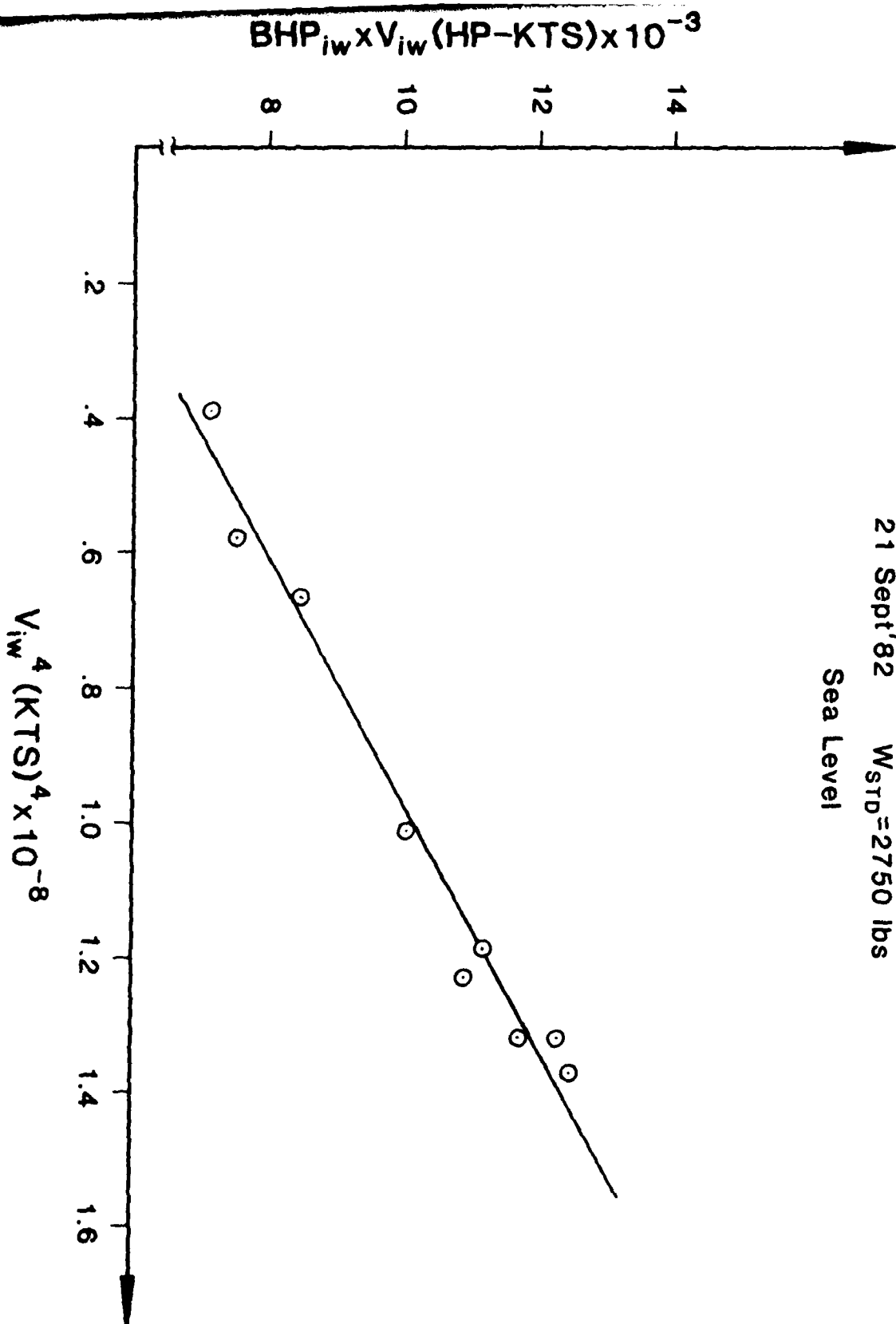
NL

END
DATE
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

Beechcraft Sierra N6636D
 21 Sept'82 $W_{STD}=2750$ lbs
 Sea Level

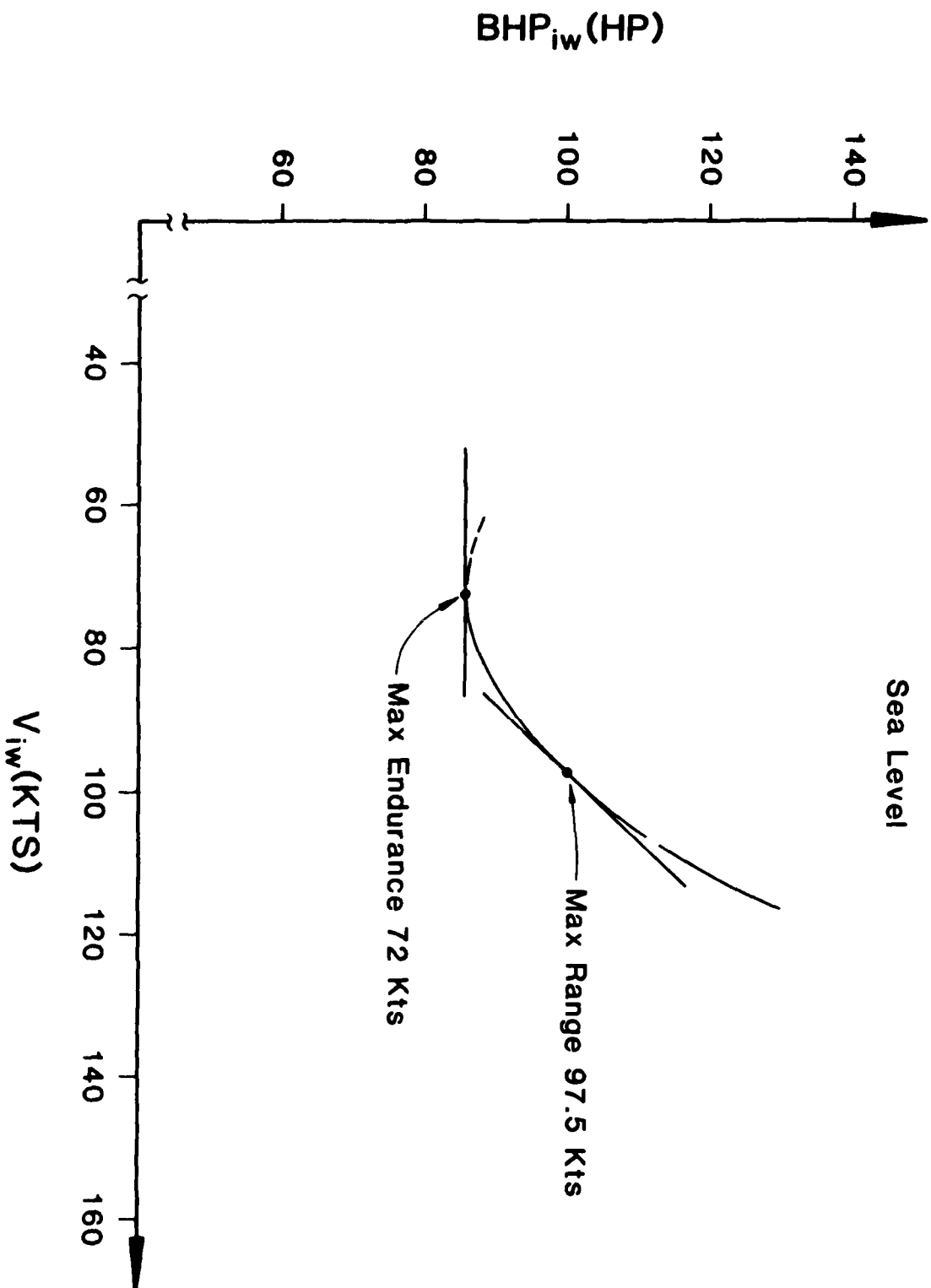


Beechcraft Sierra N6636D

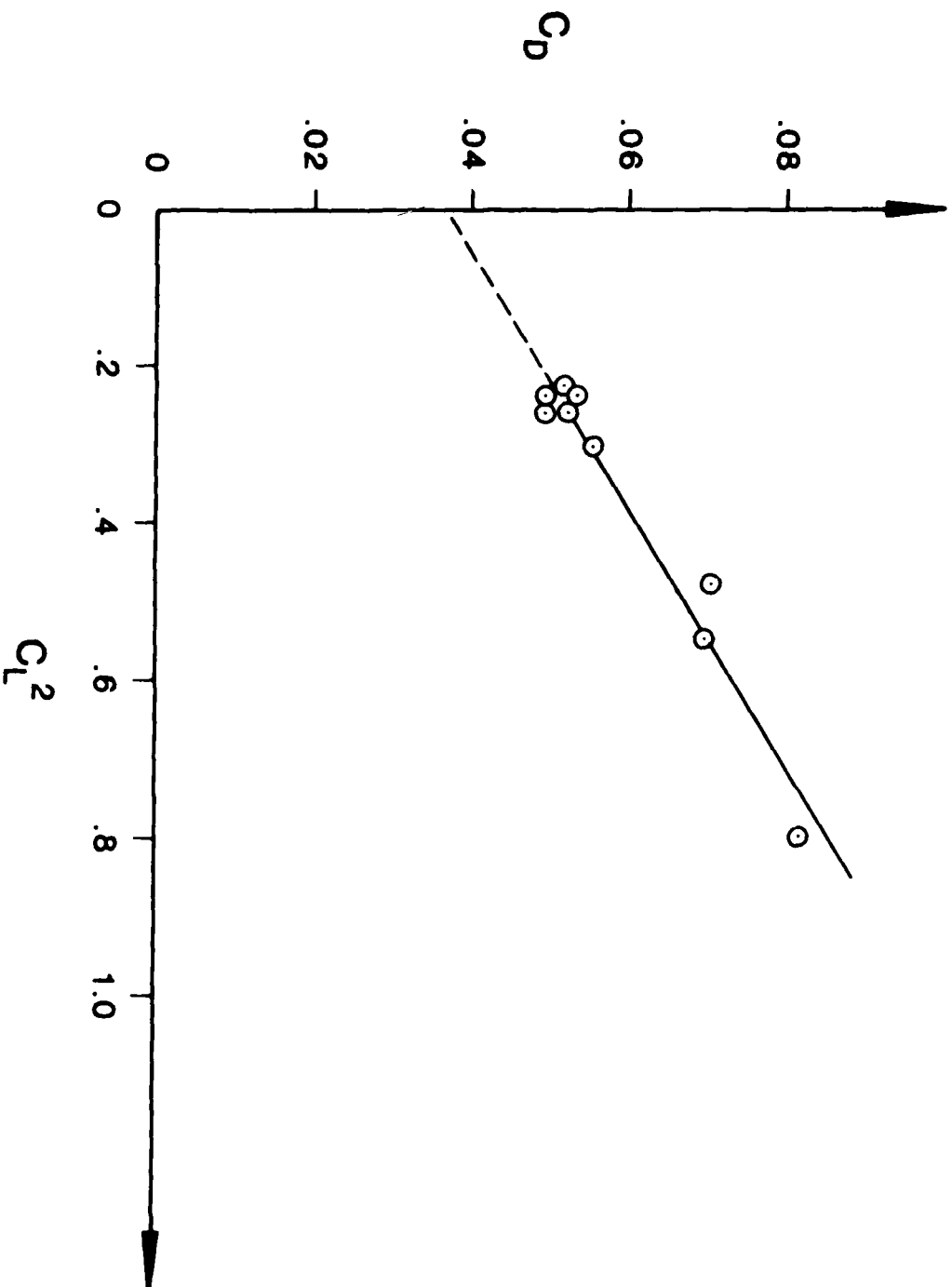
21 Sept'82

$W_{STD} = 2750$ lbs

Sea Level

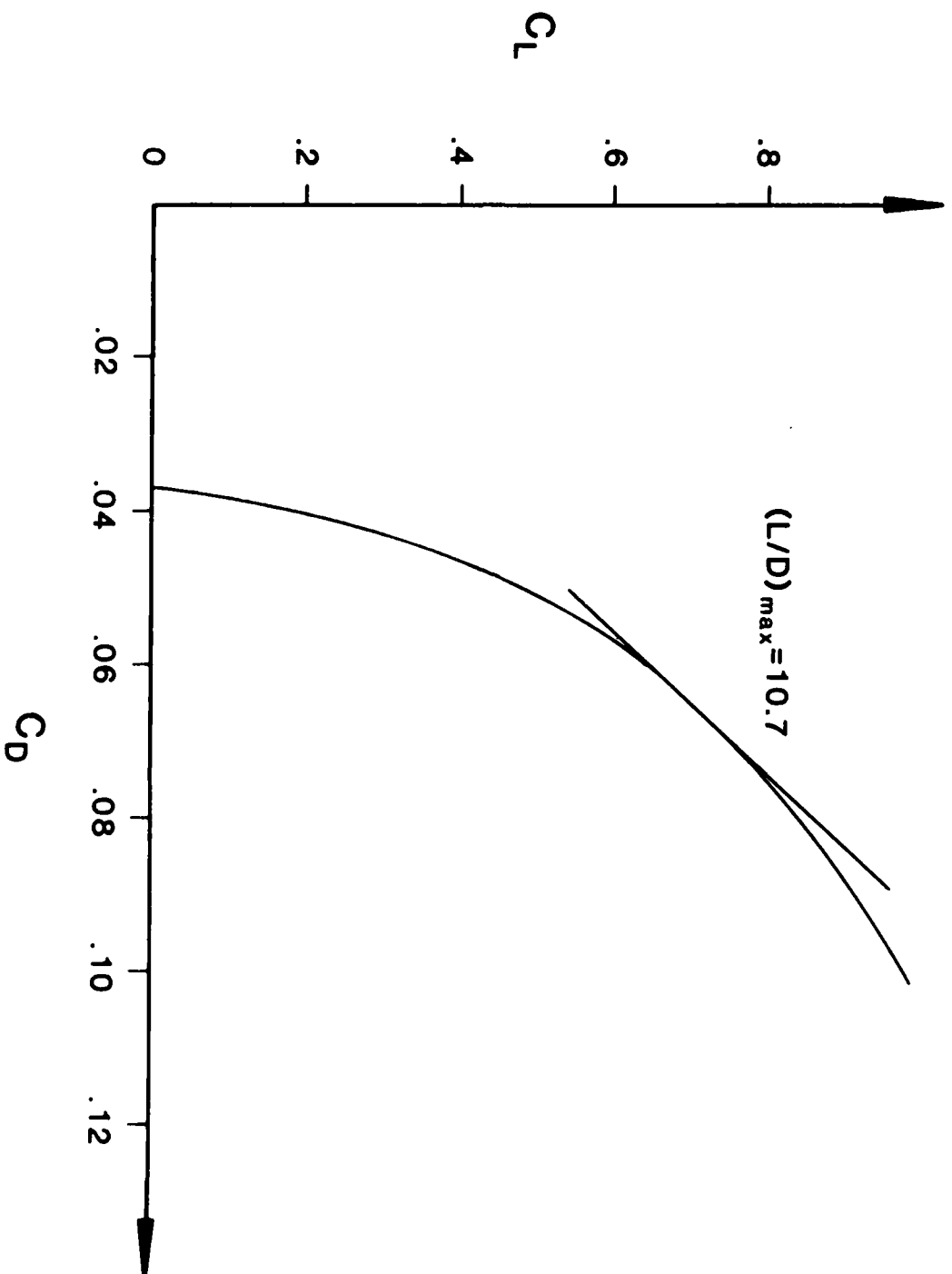


Beechcraft Sierra N6636D
 21 Sept'82 $C_D = .037 + .06C_L^2$



Beechcraft Sierra N6636D

21 Sept'82 $C_D = .037 + .06C_L^2$

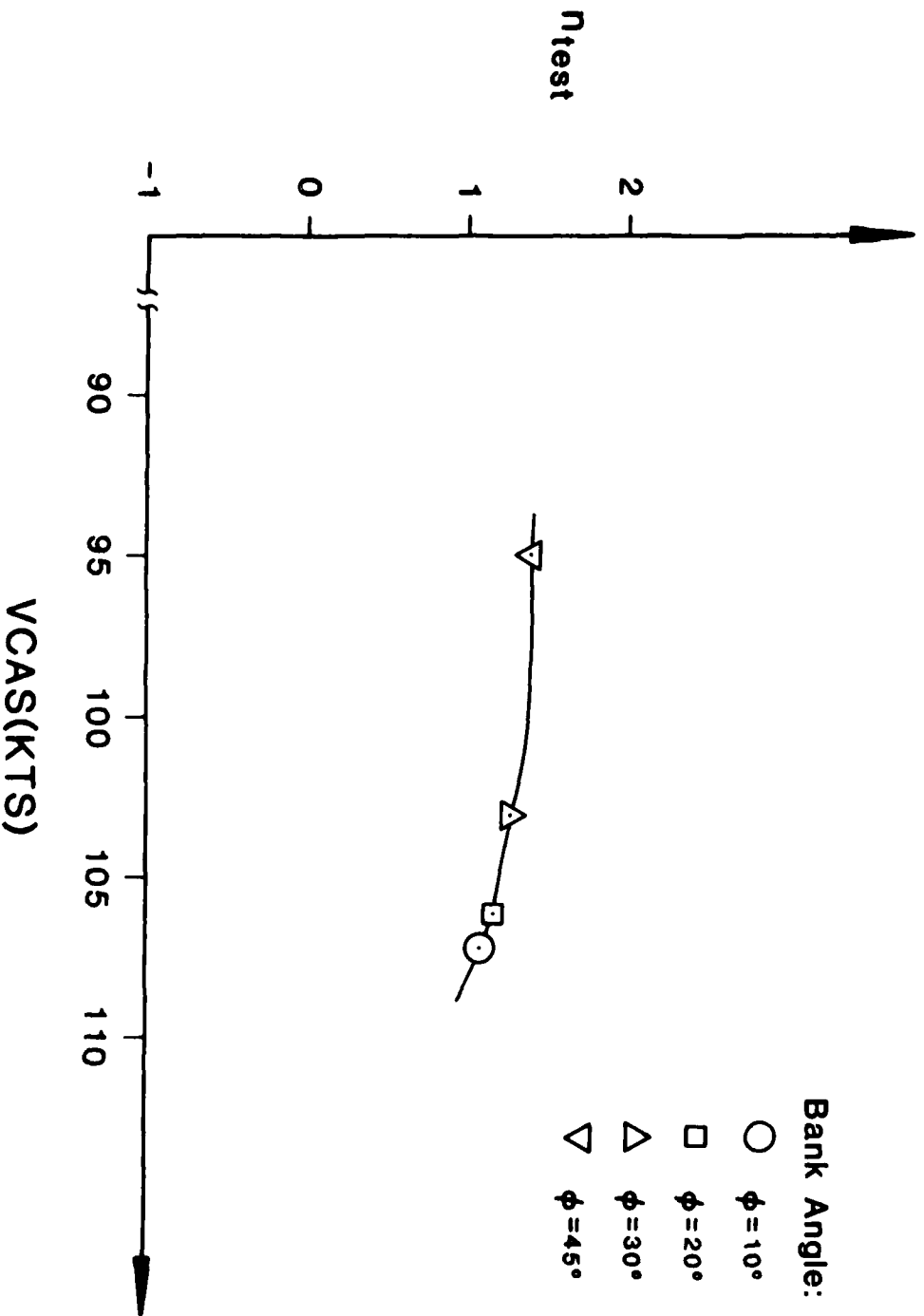


[illegible]

Beechcraft Sierra N6636D

21 Sept'82 $H_{test} = 10,000$ feet

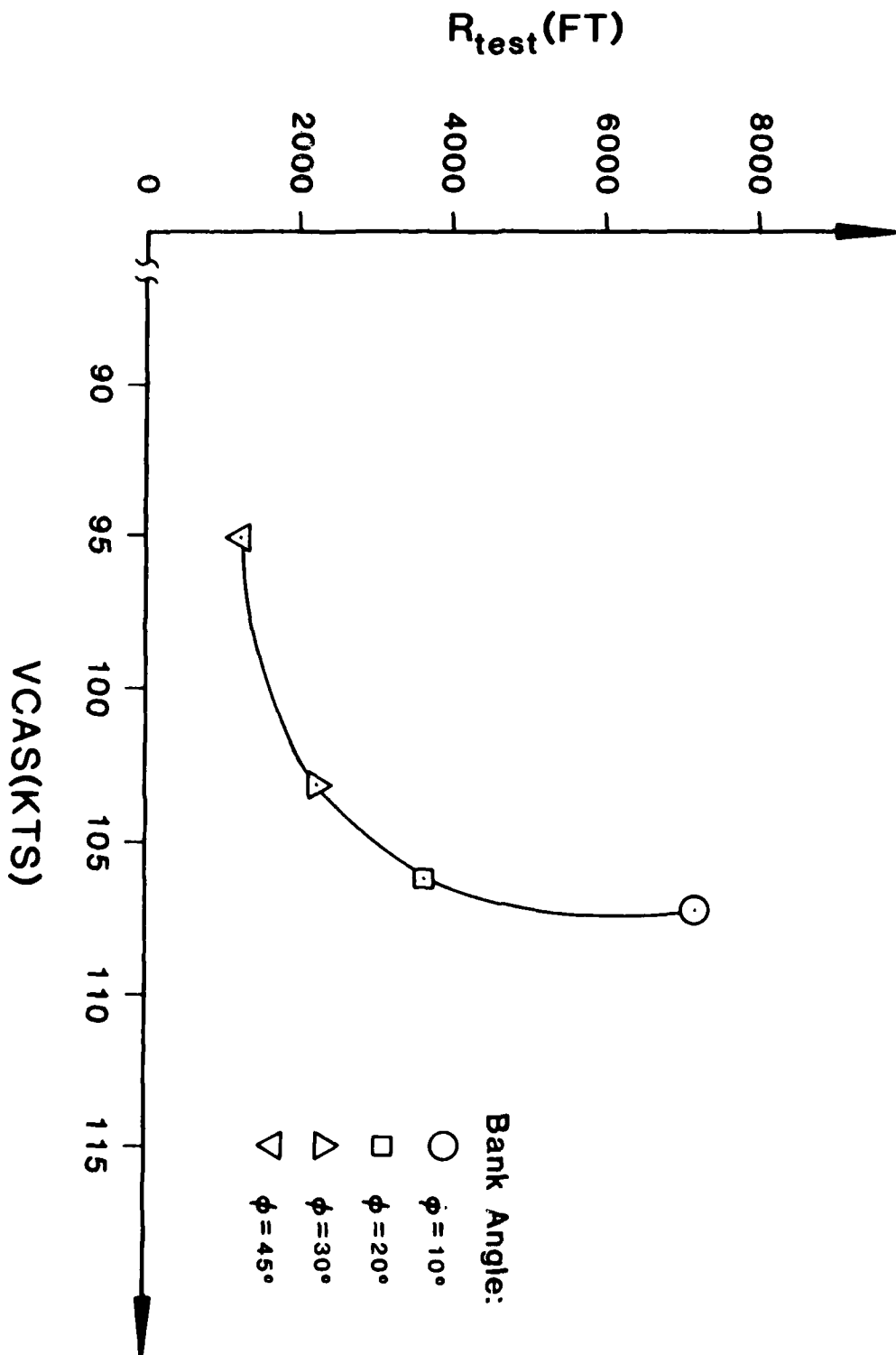
Steady Turns



Beechcraft Sierra N6636D

21 Sept'82 $H_{test} = 10,000$ feet

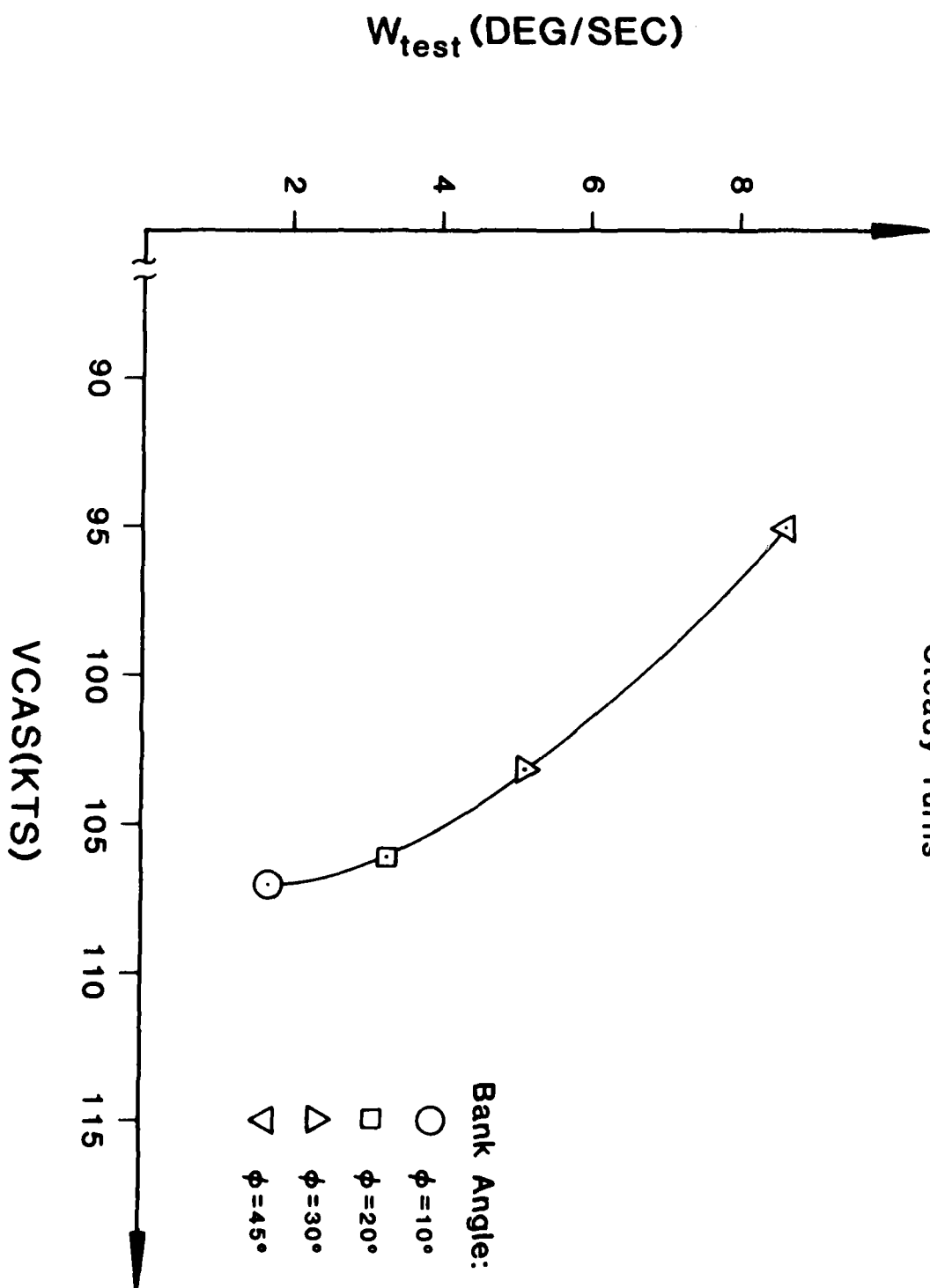
Steady Turns



Beechcraft Sierra N6636D

21 Sept'82 $H_{test}=10,000$ feet

Steady Turns



DATE 18 Feb 83

INSTRUCTOR Crenshaw

STUDENT Muller

Koehn

AIRCRAFT NO. N18892

PRE-FLIGHT TACH TIME 1644.53

POST-FLIGHT TACH TIME 1645.37

REMARKS:

FIELD DATA

TAKEOFF DATA: FIELD ELEVATION

ALTITUDE 29.99

WINDS 320/5 knots

PRESS. ALT. 6000 ft

TEMP 34°F

GD ROLL (P) 2200 ft

GD ROLL (A) 1900 ft

TAKEOFF V₁ 76 mph

CLIMB DATA

FLIGHT DATA																	
RUN NO.	IAS	TACH TIME	CA. °C		TOTAL TIME SECS	RPM MAP	VVI (FPM)/ELAPSED TIME (sec's)										
			-500	ALT			+500	-400	-300	-200	-100	ALT	+100	+200	+300	+400	+500
1	81	1644.78	+10	+9	+8	116	2600/ 2010	600/12	610/21	550/32	510/43	520/35	530/66	510/81	530/92	530/105	520/116
2	100	1644.94	+10	+9	+9	132	2650/ 2190	700/12	530/22	510/34	500/47	480/61	500/76	510/87	500/102	430/111	410/132
3	125	1645.16	+11	+10	+8	267	2700/ 2150	150/10	380/13	180/25	200/37	210/45	230/57	200/66	280/82	280/102	250/126
4																	
5																	
6																	
7																	
8																	
9																	
10																	

CLINICAL RESEARCH

[illegible]

1. V_i (Kts.) indicated airspeed
2. V_c (Kts.) $\approx V_e$ (Kts.), p. 5-10 F.N.
3. H_i (ft.) indicated pressure altitude
4. H_c (ft.) calibrated pressure altitude, p. 5-12 F.N.
5. Test Weight, W_t = Basic Empty Weight + crew + fuel
6. $V_{iw} = V_e \left(\frac{W_s}{W_t} \right)^{\frac{1}{2}} = \textcircled{2} \times \left(\frac{W_s}{\textcircled{5}} \right)^{\frac{1}{2}}$
7. $\left(\frac{dH}{dt} \right)_t$ Plot H_c versus time. Draw a tangent to the curve at test altitude. Slope is $\left(\frac{dH}{dt} \right)_t$
8. $\frac{T_t}{T_s}$ = $\frac{\text{Absolute Test Temperature at test altitude}}{\text{Absolute Std. Temperature}}$
9. Density Correction to Rate of Climb
 $\left(\frac{dH}{dt} \right)_d = \left(\frac{dH}{dt} \right)_t \sqrt{\frac{T_t}{T_s}} = \textcircled{7} \times \sqrt{\textcircled{8}}$
10. BHP_t from engine chart for actual test altitude temperature
11. BHP_s from engine chart for standard temperature at test altitude
12. $\Delta BHP = BHP_s - BHP_t = \textcircled{11} - \textcircled{10}$
13. Δ , pressure ratio from altitude charts for H_c
14. σ , density ratio = $\frac{\sigma}{\sigma_0} = \frac{\textcircled{13} \times \frac{288.15}{T_t}}{\frac{288.15}{K}}$
15. C_p , Propeller Power Coefficient knowing BHP_t , RPM and σ
16. J , Propeller Advance Ratio knowing V_e , $\sqrt{\sigma}$ and RPM

17. η , Propeller Efficiency knowing η_p and η_c
18. Engine Power and Propulsive Efficiency Correction to Rate of Climb

$$\dot{L} \left(\frac{dH}{dt} \right) = \frac{W}{K_S} \left[\frac{BHP}{K_S} + BHP_S \left(1 - \frac{1_S}{1_C} \right) \right] 550$$

$$\dot{L} \left(\frac{dH}{dt} \right) = \frac{W}{K_S} \left[\textcircled{12} + \textcircled{11} \left(1 - \frac{1}{\textcircled{8}} \right) \right] 550$$

$$19. \left(\frac{dH}{dt} \right)_p = \left(\frac{dH}{dt} \right)_d + \dot{L} \left(\frac{dH}{dt} \right) = \textcircled{9} + \textcircled{18}$$

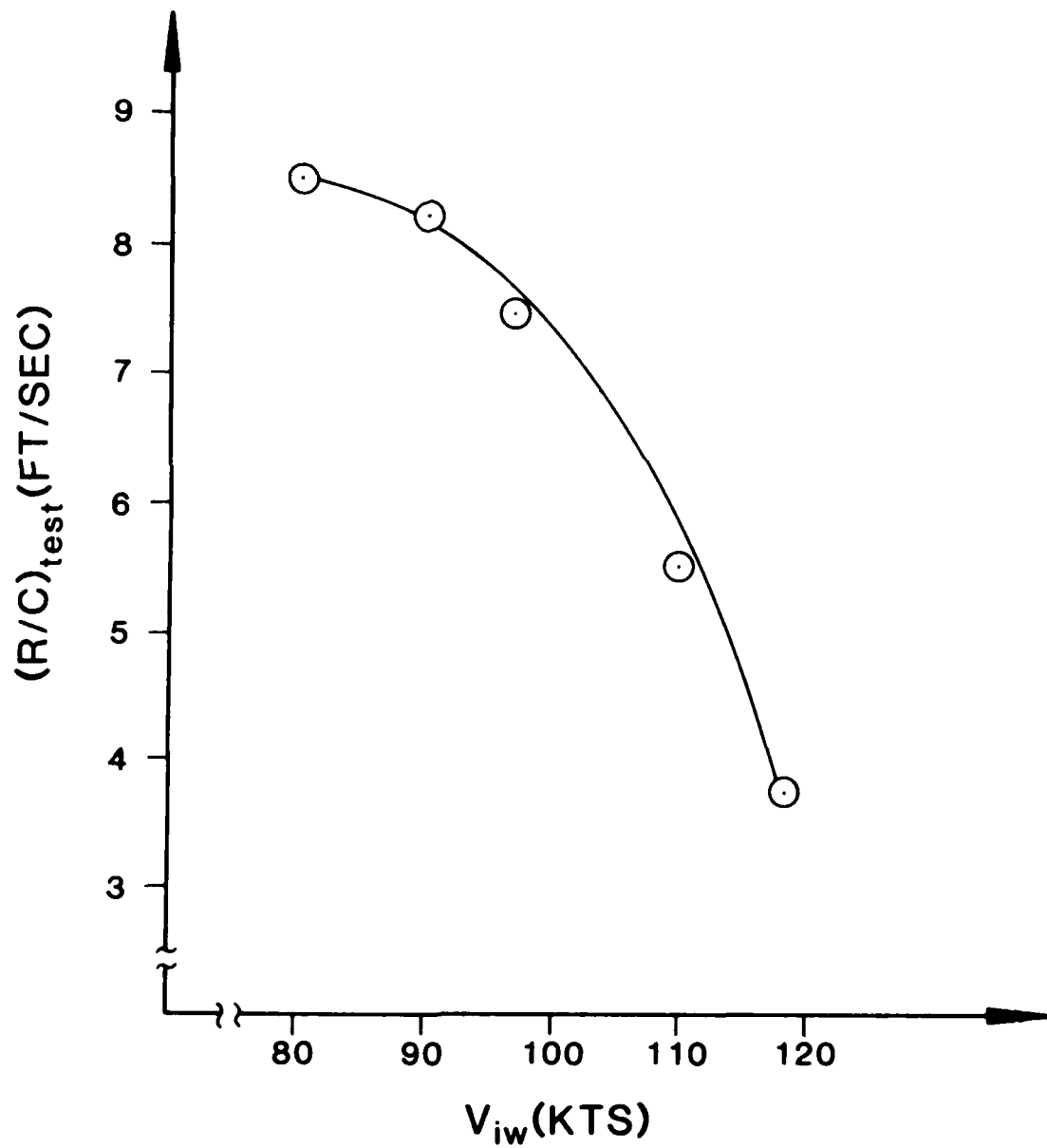
20. Weight Correction to Rate of Climb

$$\left(\frac{dH}{dt} \right)_{STC} = \left(\frac{dH}{dt} \right)_p \sqrt{\frac{W_S}{W_T}} 60 = \textcircled{19} \times \sqrt{\textcircled{5}} \times 60 \text{ (FPM)}$$

Beechcraft Sierra N18892

21 Feb'83 $H_{test}=8500$ feet

Sawtooth Climbs

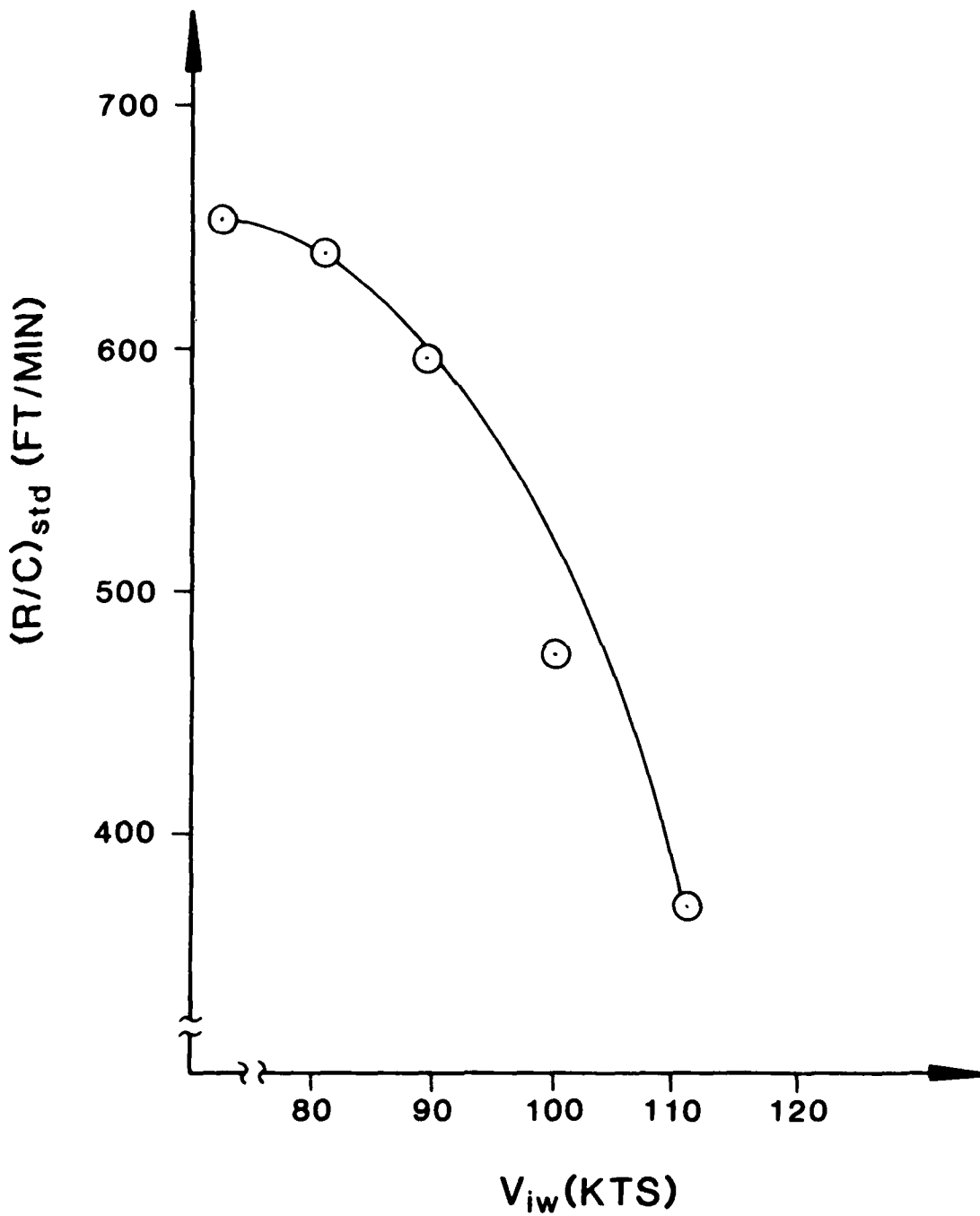


Beechcraft Sierra N18892

21 Feb'83 H_{std} =Sea Level

W_{std} =2750 lbs

Sawtooth Climbs



ROW NO.	(TIME) LAS	TACH TIME	°C		TOTAL TIME IN SECONDS												
			+500	ALT	-500	-100	-200	-300	-400	-500	-600	-700	-800	-900	-1000		
1	92	164476	+7	+8	+9	63	-750	-900	-950	-960	-950	-950	-950	-900	-850	-800	-700
							5	13	18	25	30	36	42	48	54	60	63
2	115	164491	+8	+8	+9	53	-920	-1000	-1100	-1100	-1000	-950	-900	-850	-800	-750	-650
							5	10	15	20	22	32	38	44	48	53	53
3	140	164511	+8	+9	+9	34	-1500	-	-1700	-	-1600	-	-1700	-1800	-1800	-1800	-1300
							4	-	9	-	17	-	25	-	30	34	34
4																	
5																	
6																	
7																	
8																	
9																	
10																	

DESIGN PERFORMANCE DATA REPORT

1. NAME OF PROJECT

2. AREA OF PROJECT

3. NAME OF ENGINEER

NO.	V_i (Kts)	V_c (Kts)	H_i (ft.)	H_c (ft.)	W_t (lbs.)	V_{iw} (Kts)	$\left(\frac{dH}{dt}\right)_t$ (ft/s)	T_t (°K)	T_s (°K)	$\left(\frac{dH}{dt}\right)_d$ (ft/s)	$\left(\frac{dH}{dt}\right)_{std}$ (ft/s)	$(p.p.s.)$ (in./s)	V_{true} (Kts)	C_L	C_L^2	$C_L C_D$			
1	79.89	79.0	8500	8497	2558	80.4	-16.22	281	271	1.037	-16.82	-1046	7287	7472	91.39	1.07	1971	145	5431
2	99.87	98.7	8500	8498	2549	100.6	-18.18	281	271	1.037	-18.85	-1175	7287	7472	114.18	683	113	466	6.044
3	121.58	121.1	8500	8497	2537	123.6	-29.63	282	271	1.041	-30.84	-1927	7287	7446	140.34	451	099	203	4.556

- V_i (Kts.) indicated airspeed
- V_c (Kts.) ≈ V_e (Kts), p. 5-10 F.M.
- H_i (ft.) indicated pressure altitude
- H_c (ft.) calibrated pressure altitude, p. 5-12 F.M.
- Test Weight, W_t = Basic Empty Weight + crew + fuel
- V_{iw} = V_e $\left(\frac{W_s}{W_t} \right)^{1/2}$ = $\frac{7}{5} \times \left(\frac{W_s}{5} \right)^{1/2}$
- $\left(\frac{dH}{dt} \right)_t$ Plot H_c versus time. Draw a tangent to the curve at test altitude. Slope is $\left(\frac{dH}{dt} \right)_t$
- $\frac{T_t}{T_s}$ = $\frac{\text{Absolute Test Temperature at test altitude}}{\text{Absolute Std. Temperature}}$
- Density Correction to Rate of Descent
 $\left(\frac{dH}{dt} \right)_d = \left(\frac{dH}{dt} \right)_t \sqrt{\frac{T_t}{T_s}} = \textcircled{7} \times \sqrt{\textcircled{8}}$
- Weight Correction to Rate of Descent
 $\left(\frac{dH}{dt} \right)_{STD} = \left(\frac{dH}{dt} \right)_d \sqrt{\frac{W_s}{W_t}} \quad 60 = \textcircled{9} \times \sqrt{\textcircled{5}} \quad \times 60 \text{ (FPM)}$
- δ, pressure ratio from altitude charts for H_c
- σ, density ratio = $\frac{\delta}{T_t \text{ °K}/288.15} = \frac{\textcircled{11} \times 288.15}{T_t \text{ °K}}$
- V_{true} (Kts) = $\frac{V_e}{\sigma} = \textcircled{2} \div (\textcircled{12})^{1/2}$
- C_L = $\frac{W_t}{\frac{1}{2} \rho_0 (V_e \times 1.689)^2 S} = \frac{\textcircled{13}}{\frac{1}{2} \rho_0 (\textcircled{12} \times 1.689)^2 S}$

DESIGN PERFORMANCE DATA REVISED 10-1-66

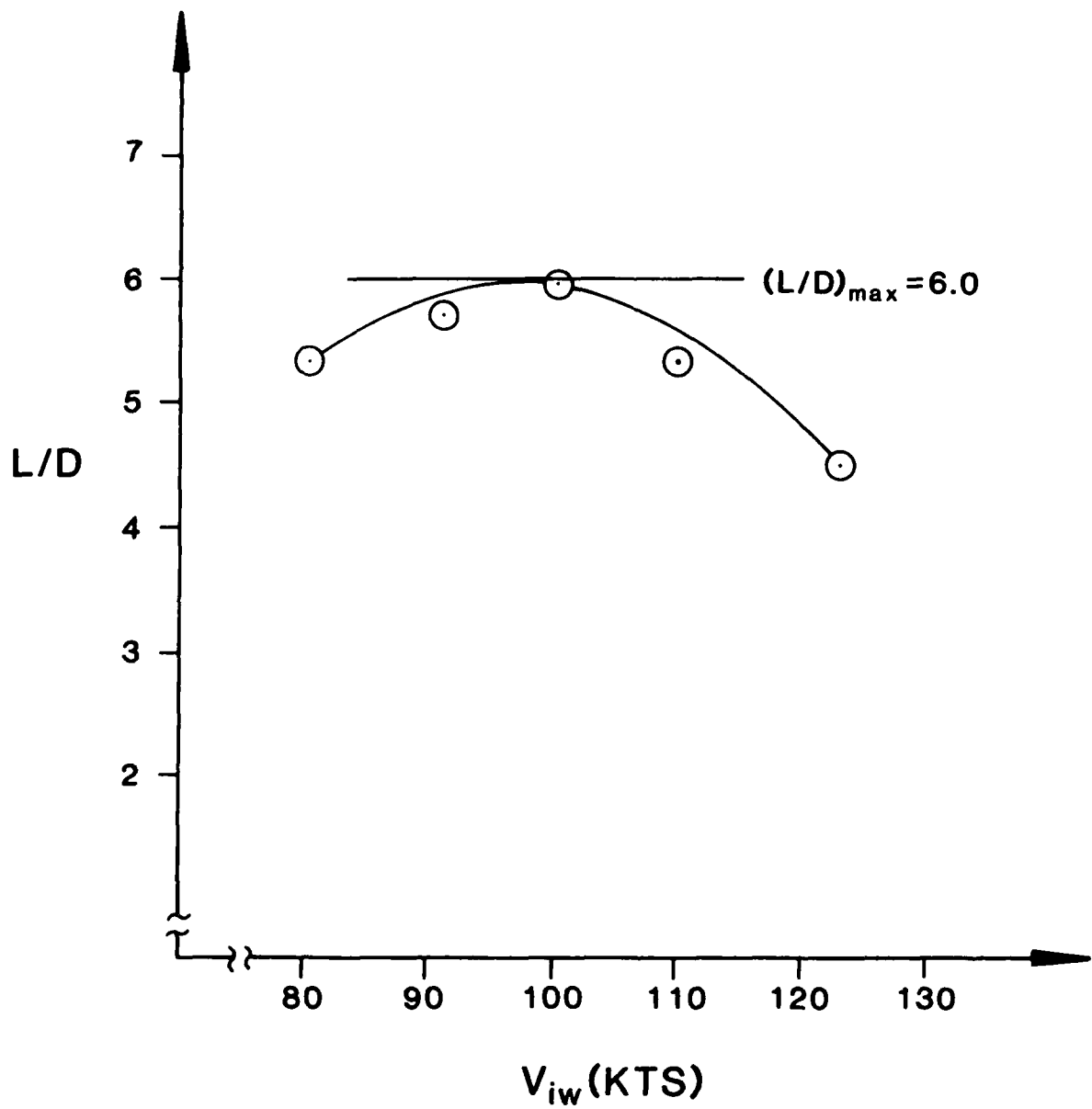
$$15. \quad \sigma_p = \frac{(dH/dt)_{p, true}}{V_p \times 1.089} = \frac{1.0 \times 1.089}{1.0 \times 1.089} s$$

Beechcraft Sierra N18892

21 Feb'83 Throttle Idle and

Prop at High Pitch

Sawtooth Descents



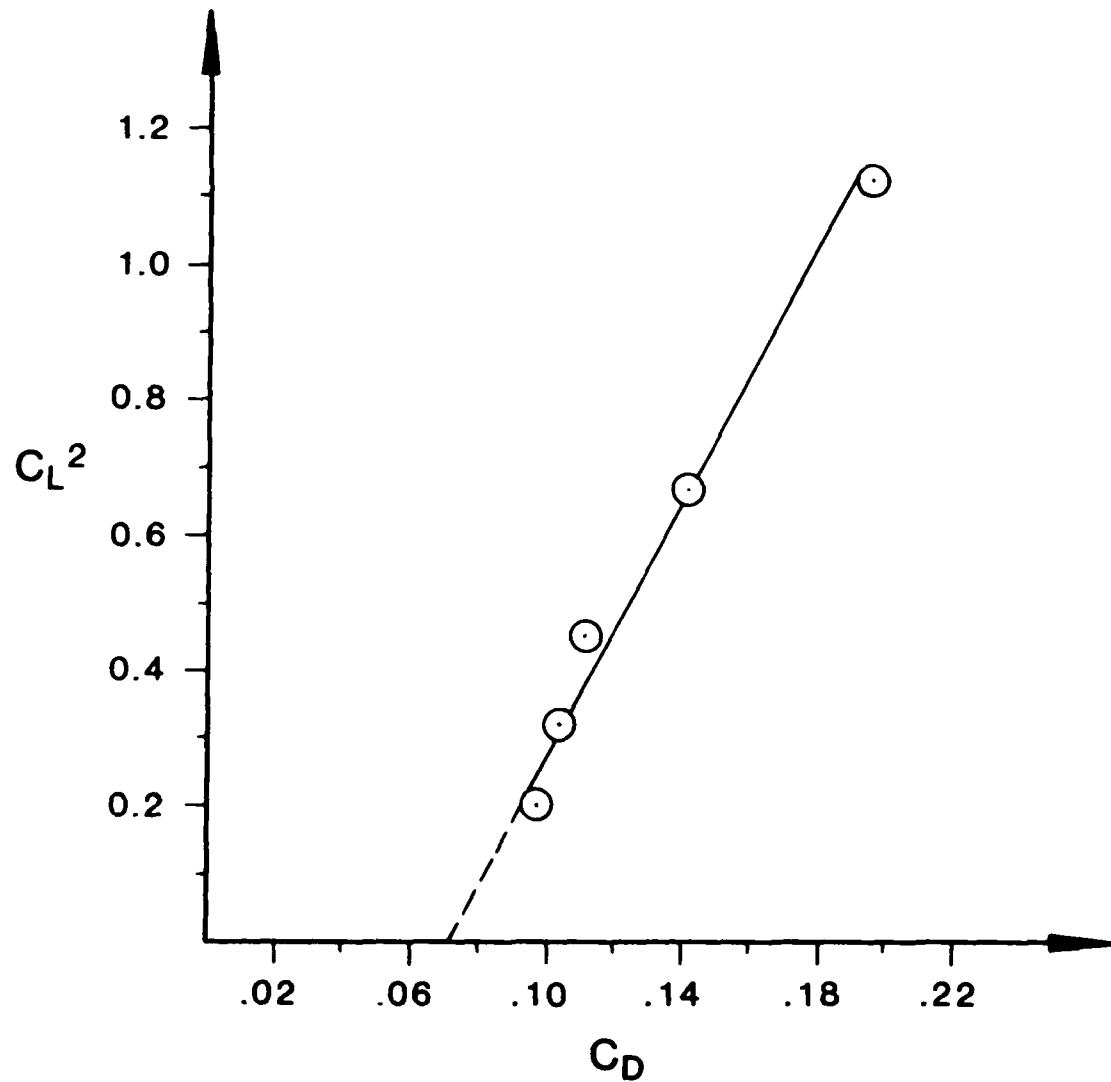
Beechcraft Sierra N18892

21 Feb'83 $C_D = .07 + .10 C_L^2$

Throttle Idle and Prop at

High Pitch

Sawtooth Descents



Beechcraft Sierra N18892

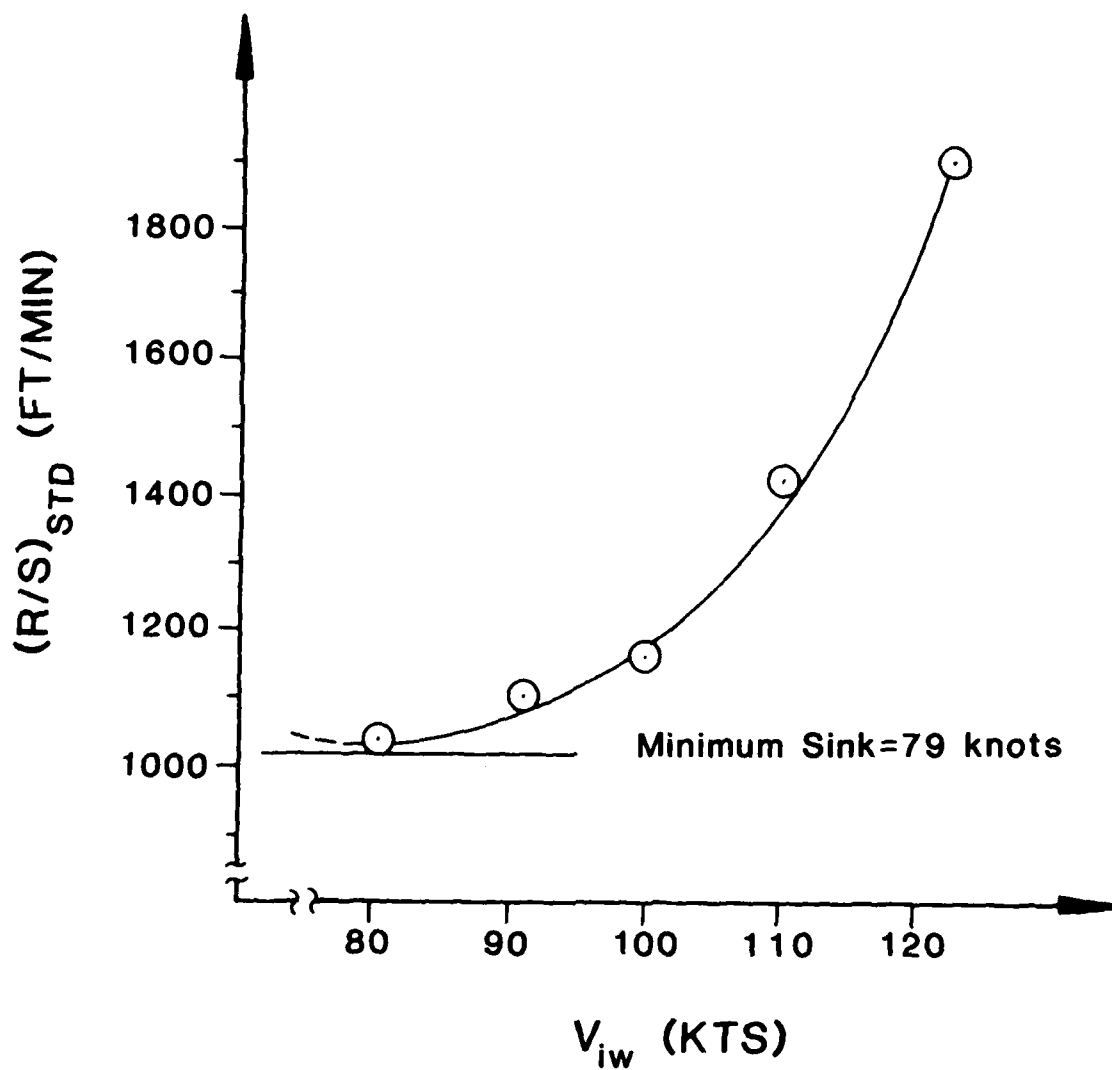
21 Feb'83

$W_{STD} = 2750$ pounds

Sea Level

Throttle Idle and Prop at High Pitch

Sawtooth Descents



APPENDIX E

Test Plan Sundowner 180 C23 Limited Flying Qualities Evaluation

UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

DEPARTMENT OF AERONAUTICS

AERO 495

TEST PLAN

SUNDOWNER 180 C23 LIMITED FLYING QUALITIES EVALUATION

AUGUST 1982

E-2

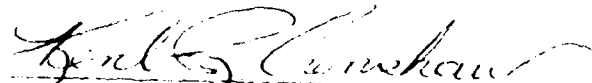
TEST PLAN

DEPARTMENT OF AERONAUTICS

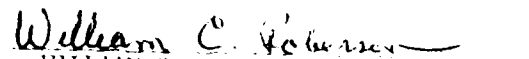
SUNDOWNER 180 C23 LIMITED FLYING QUALITIES EVALUATION

AUGUST 1982

This test plan has been prepared by:


KENT R. CRENSHAW, Major, USAF
Aero 495 Course Director
Department of Aeronautics

Reviewed by:


WILLIAM C. ROBERSON, Captain, USAF
Aero 495 Course Pilot
Department of Aeronautics

Reviewed by:

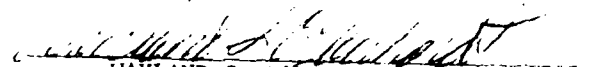

WAYLAND S. EBERHARDT
Director of Flight Operation
Hedrick Beechcraft Inc.

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TEST PLAN

DEPARTMENT OF AERONAUTICS

SUNDOWNER 180 C23 LIMITED FLYING QUALITIES EVALAUTION

INTRODUCTION

A limited flying qualities evaluation of the Beech Sundowner 180 C23 will be conducted by U. S. Air Force Academy, Department of Aeronautics (DFAN) faculty pilots and students enrolled in Aero 495. Flight testing will be conducted during the Fall 1982 semester from the 13th to 18th week of classes. Results of the evaluation will be presented in a formal oral report given by each of two student test teams.

OBJECTIVES

The primary objective of this test program is to provide the cadets with practical experience in flying qualities testing. They will qualitatively and quantitatively evaluate the Beech Sundowner 180 C23 as a primary trainer for Class I. The aircraft will be tested for compliance with MIL-F-8785C, Flying Qualities of Piloted Airplanes. Only those paragraphs of MIL-F-8785C listed under the Test Description/Procedures section of this test plan will be used in evaluating the Sundowner.

AUTHORITY

This test program will be conducted by Department of Aeronautics faculty and students as a part of the curriculum for Aero 495, a course in flight test techniques. The program has the approval of the Superintendent, the Dean of the Faculty, the Head of the Department of Aeronautics, and the Director of Flight Operation of Hedrick Beechcraft Inc.

TEST TEAM ORGANIZATION

Test team organization shown in Figure 1 will consist of two DFAN faculty pilots and two student flight test engineer teams. Each test team will be assigned to fly with one faculty pilot. A Test Director for each team will be appointed to coordinate the evaluation effort. He will appoint individuals to be in charge of each test area (i.e., data monitors). It will be the data monitor's responsibility to specify the test to be flown in support of his test area. Test areas to be assigned are weight and balance; longitudinal static stability and control; maneuvering flight; lateral-directional stability and control; dynamic stability; and high angle of attack (AOA) flying qualities.

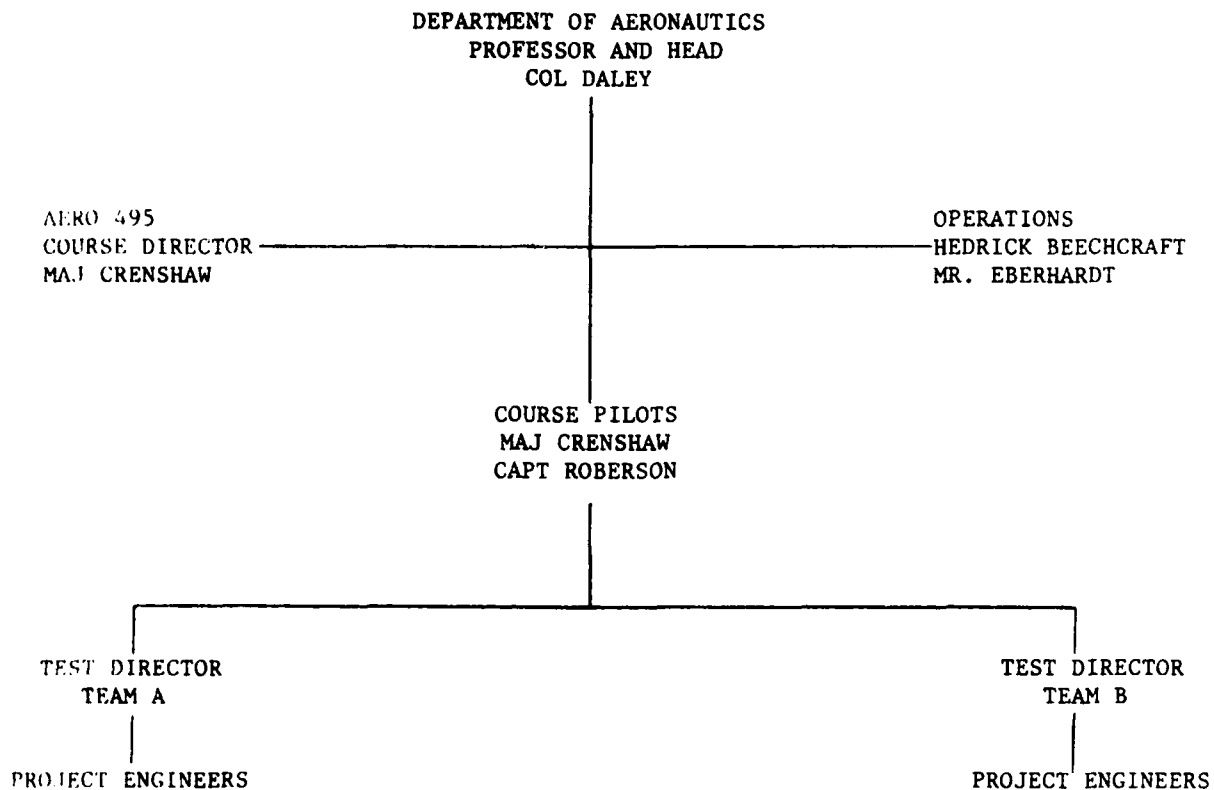


Figure 1. Organization Chart

SCOPE/SCHEDULE

The evaluation will consist of sorties as specified in Table I.

Table I. Data Sorties

<u>Test</u>	<u>Sorties Per Test Team</u>	<u>Flight Time Per Sortie</u>
• Flight #3 Longitudinal and Lateral- Directional Stability and Control; Maneuvering Flight	2.5	1.0
• Flight #4 Dynamic Stability; Stalls	2.5	1.0
	—	
*Total	5.0	

*One sortie will be shared by both test teams. Flight #3 and #4 are scheduled as shown on the Integrated Academics and Flying Schedule for Aero 495. Mission time will not exceed 1.0 hour.

LIMITATIONS

The following limitations will be observed during this evaluation.

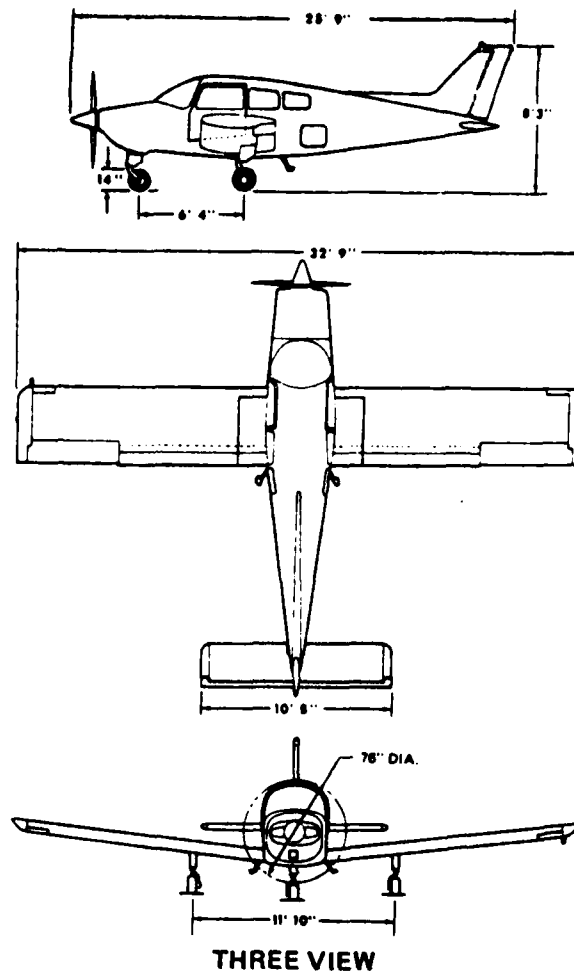
- A. The aircraft will be operated in the normal category in accordance with the Airplane Flight Manual, FAR Part 91 and all Beech Aero Club Operating Instructions.
- B. All data sorties will be flown with one DFAN faculty pilot and two cadets.
- C. Testing will only be accomplished under VFR daytime conditions at 10,000 feet MSL and below.
- D. All testing will be accomplished within the local flying area of Colorado Springs.

TEST AIRCRAFT DESCRIPTION

The Beechcraft Sundowner 180 C23, manufactured by Beech Aircraft Corporation, is a four-place, fixed gear, general aviation aircraft powered by one 4-cylinder, 180 HP Avco Lycoming engine. The propeller is a Sensenich fixed pitch, two-blade prop with spinner. See Figure 2 for general dimensions and Table II for Aircraft Limitations.

**BEECHCRAFT Sundowner 180
C23 (M-1285 and After)**

$S = 146 \text{ ft}^2$
 $AR = 7.5$
 $\bar{c} = 52.7 \text{ inches}$



**Figure 2. Three View of Sundowner 180 C23
(Reference 1)**

Table II. Aircraft Limitations

	IAS Knots/mph
Never Exceed Speed (V_{NE})	152/175
Maximum Maneuvering Speed (V_A)	118/136
Maximum Cruising Speed in Turbulent Air (V_C)	136/156
1G Stall Speed, Flaps Up (2,450 lbs) (power idle)	63/ 72
Maximum Ramp Weight	2,455 lbs
Maximum Takeoff and Landing Weight	2,450 lbs
Flight Maneuvering Load Factor:	
Flaps Up	+3.8 to -1.9G
Flaps Down	+1.9G
Maneuver Bank Angles No More Than 60°	
Sideslips are restricted to 30 seconds duration	
Service Ceiling	12,600 feet
Test Plan Ceiling	10,000 feet

FLIGHT TEST INSTRUMENTATION

Test data will be hand recorded using standard cockpit instrumentation, a mechanical force gage for elevator forces, a six volt electric strain gage device for rudder pedal forces, an accelerometer, and a stopwatch. As an option, a cassette tape player may be used to record data.

WEIGHT AND BALANCE

Detailed weight and balance records for each aircraft are available at Hedrick Beechcraft and will be reproduced in a handout for student use. Prior to every data mission, student test engineers will calculate aircraft weight and balance data for both takeoff and landing. Each test team will evaluate the longitudinal and maneuvering flying qualities of the Sundowner in both a forward and aft center of gravity (c.g.) condition. The only approved means of c.g. control will be in passenger seating, i.e., heaviest cadet either in front or back seat. Under no circumstances will the aircraft be operated outside the Flight Manual forward and aft c.g. limits.

TEST DESCRIPTION/PROCEDURES

A. General

All flying qualities tests will be performed with the engine operating and the wing flaps retracted. All data will be hand and/or voice recorded; and, as required, manually reduced to standard conditions.

B. Longitudinal Static Stability and Control

1. The aircraft will be evaluated against the following paragraphs of reference 2 at the test points in Table III.

3.2.1.1 Longitudinal Static Stability

3.2.3.1 Longitudinal Control in Unaccelerated Flight

2. (3.2.1.1) The test will be accomplished using one of the methods described in reference 3. The airspeed will be varied over a range of ± 15 percent of the trim speed. The altitude will be maintained within $\pm 1,000$ feet of the test altitude.

3. Using data from both aft and forward c.g. locations, the stick-free and stick-fixed neutral points will be determined using the procedure in reference 3.

C. Maneuvering Flight

1. The aircraft will be evaluated against the following paragraphs of reference 2 at the test points in Table III.

3.2.2.2 Control Feel and Stability in Maneuvering Flight

3.2.2.2.1 Control Forces in Maneuvering Flight

3.2.2.2.2 Control Motions in Maneuvering Flight

3.2.3.2 Longitudinal Control in Maneuvering Flight

2. (3.2.2.2, 3.2.2.2.1, 3.2.2.2.2) Data for evaluating the aircraft against these paragraphs will be obtained using one of the methods described in reference 3. Altitude will be maintained within $\pm 1,000$ feet of the trim altitude. "G" will be relaxed during rollout to avoid excessive asymmetric "G" loads on the aircraft.

3. Data from both aft and forward c.g. tests will be used to determine the stick-free and stick-fixed maneuver points in accordance with the procedure outlined in reference 3.

Table III. Static and Dynamic
Stability and Control Test Points

*Test Point Nu	Pressure Altitude (feet)	Trim Airspeed (KIAS)
1	8,000	80
2	8,000	90
3	9,000	80
4	9,000	90

*Accomplish each test point at both forward and aft c.g. for longitudinal and maneuvering flight tests.

D. Lateral-Directional Stability and Control

1. The aircraft will be evaluated against the following paragraphs of reference 2 at the test points in Table III.

- 3.3.4 Roll Control Effectiveness
- 3.3.4.4 Linearity of Roll Response
- 3.3.4.5 Wheel Control Throw
- 3.3.2.5 Control of Sideslip in Rolls
- 3.3.2.6 Turn Coordination
- 3.2.3.7 Longitudinal Control in Sideslip
- 3.3.5 Directional Control Characteristics
- 3.3.6.1 Yawing Moments in Steady Sideslips
- 3.3.6.2 Side Forces in Steady Sideslips
- 3.3.6.3 Rolling Moments in Steady Sideslips

2. (3.3.2.6) This test will be accomplished by first trimming the aircraft in wings-level flight at the desired test point. Then a coordinated 45° bank turn will be established at the trim airspeed.

3. (3.2.3.7, 3.3.5, 3.3.6.1, 3.3.6.2, 3.3.6.3) Testing in these areas will be accomplished using the techniques described in reference 3.

4. Altitude for all tests will be maintained within $\pm 1,000$ feet of the trim altitude.

5. Maximum sideslip duration will not exceed 30 seconds.

E. Dynamic Stability

1. The aircraft will be evaluated for compliance with the following paragraphs of reference 2.

- 3.2.1.2 Phugoid Stability
- 3.2.2.1 Short-Period Response
- 3.3.1.1 Lateral-Directional Oscillations (Dutch Roll)
- 3.3.1.2 Roll Mode
- 3.3.1.3 Spiral Stability

2. These tests will be accomplished at the points listed in Table III using the test methods specified in reference 3.

3. (3.3.1.1) The Dutch Roll will be excited using ramp rudder inputs applied smoothly to $\frac{1}{2}$ deflection either side of neutral. Sharp or rapid rudder inputs, which impose high loads on the aircraft structure, will not be used to excite the Dutch Roll.

4. (3.3.1.2) The aircraft will be trimmed initially for wings-level flight at the desired test point. From a coordinated 45° bank turn at the trim airspeed, roll performance will be tested by rolling the aircraft with a step aileron input to the same bank angle in the other direction. Roll performance will be measured at $\frac{1}{2}$ and full control wheel deflections.

F. High AOA Tests

1. The aircraft will be tested for compliance with the following paragraphs of reference 2 and at the test points shown on Table IV.

Table IV. High AOA Test Points

Test Point Nu	Pressure Altitude (feet)	*Trim Airspeed (KIAS)
5	9,000	1.2 V_s
6	10,000	1.2 V_s

*For the purpose of determining trim airspeed, V_s will be the wings level, flaps up, power off stall speed of 72 mph/63 KIAS.

- 3.4.2 Flight at High Angle of Attack
- 3.4.2.1 Stalls
- 3.4.2.1.1 Stall Approach
- 3.4.2.1.1.1 Warning Speed for Stalls at 1g Normal to the Flight Path
- 3.4.2.1.2 Stall Characteristics
- 3.4.2.1.3 Stall Prevention and Recovery

2. The aircraft will be tested only during Phase A stalls as defined in reference 4. Emphasis during the test program will be placed on determining the adequacy of the aircraft controls during the approach to the stall and during stall recovery; the adequacy and nature of the stall warning characteristics; and the stall recovery techniques. The aircraft will not be flown into a deep stall. Recovery will be initiated when (see Table I, reference 4):

- a. a definite g-break occurs.
- b. a rapid, uncommanded angular motion develops.
- c. the aft stick stop has been reached and pitch attitude cannot be increased.
- d. sustained heavy buffet develops.

3. The aircraft will be trimmed for 1g flight at the airspeed and altitudes specified in Table IV. Using the test methods in reference 3, the aircraft will then be maneuvered so that the stall occurs at the test altitude (± 500 feet).

4. Stall recovery will be initiated at the onset of the first stall.

5. Stalls will be accomplished at 8,500 feet MSL minimum.

TRAINING

Both DFAN faculty pilots will have at least an FAA commercial pilot rating and be current in the Beech Sundowner 180 C23 in accordance with FAA and Hedrick Beechcraft Aero Club standards.

All cadets enrolled in Aero 495 will participate in the flying portion of the course as passengers only and will receive appropriate aircraft orientation and safety instruction. All the performance flight test techniques required to gather test data will be covered during classroom lectures prior to the flights for which they will be used.

CREW DUTIES

A. Pilot

1. Check local flying weather.
2. Brief students on mission profile, and ground and in-flight safety.
3. Check maintenance status of aircraft and perform pre-flight.
4. Provide a stopwatch.
5. Provide the tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
6. Act as pilot in command of the aircraft and occupy the left front seat at all times.

B. Students

1. Bring data cards and a clipboard.
2. Complete aircraft weight and balance form.
3. Compute takeoff data using temperature and pressure altitude provided by the pilot.
4. Provide cassette tape player for each flight. (optional)
5. Record tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
6. Cadets will be assigned to two man teams for purposes of taking flight test data. Flight crew duties will be rotated each flight. Along with the pilot who will be primarily concerned with precisely flying the aircraft, both cadets will act as lookouts and notify the pilot immediately of any aircraft sighted. The cadet in the right front seat will act as data observer and timekeeper, and the cadet in the rear seat will act as data recorder.

SAFETY

Flight personnel will adhere to the following while on the flightline and in and around the aircraft:

- a. Smoking is prohibited in or near the aircraft.
- b. Seat belts will be worn at all times.
- c. Flight personnel will be seated in the aircraft prior to engine start and will remain seated until the engine is stopped.

- d. Remain clear of the propeller area at all times.
- e. Do not stand, walk, or lean on the aircraft except in designated areas.
- f. Do not open aircraft windows or doors in flight.
- g. Advise the pilot immediately upon observing another aircraft.
- h. Do not manipulate the aircraft flight controls or engine controls unless told to do so by the pilot.
- i. Advise the pilot of impending airsickness. Use the bag provided, your hat, your shoe, anything except the floor of the aircraft.
- j. Stay clear of taxiing aircraft and other flightline vehicles.

COMMAND AND CONTROL

All testing to be accomplished will be for academic purposes only and will be performed within the restrictions of the Flight Manual, Part 91 of the FAR's, Hedrick Beechcraft Aero Club Rules and the limitations imposed by this test plan.

All information with respect to this test plan is unclassified.

TEST PLAN AMENDMENTS

An amendment to this test plan is required if the flight test envelope is expanded or if any limitations in the test plan are made less restrictive. An amendment to the test plan must be reviewed and approved by the same authority who approved the basic plan.

REFERENCES

1. Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for the Beechcraft Sundowner 180 C23, Beech Aircraft Corporation, Wichita, Kansas, August 1980.
2. Military Specification, Flying Qualities of Piloted Airplanes, Department of the Air Force, Washington, D.C., MIL-F-8785C, 5 November 1980.
3. Roberts, Sean C., Flying Qualities Flight Testing of Light Aircraft for Test Pilots and Flight Test Engineers, Flight Research, Inc., Mojave, California, September 1981.
4. Military Specifications, Stall/Post-Stall/Spin Flight Test Demonstration Requirements for Airplanes, Department of the Air Force, Washington, D.C., MIL-S-83691A (USAF), 15 April 1972.

29 October 1982

Subject: Aero 495 Test Plan Revision for Sundowner 180 C23 Limited Flying Qualities Evaluation

To: Captain William C. Roberson William C. Roberson
Aero 495 Course Pilot

Mr. Wayland S. Eberhardt
Director of Flight Operation
Hedrick Beechcraft, Inc.

1. The Test Plan for the Sundowner 180 C23 Limited Flying Qualities Evaluation dated August 1982 is revised. The second to the last sentence in the paragraph titled Weight and Balance on page 5 should read:

"The only approved means of aft c.g. control will be with the use of two 50 pound lead weights secured in the baggage area. Ballast will not be carried for forward c.g. control."

2. There may not be sufficient spread in center of gravity location by using passenger seating alone to get adequate forward and aft c.g. flying qualities data. Adding lead ballast to the baggage compartment, however, does enhance the importance of checking the weight and balance prior to flight.

3. The following table is provided to aid you in computing weight and balance with ballast on board:

<u>REG NO.</u>	<u>BASIC EMPTY CONDITION + 100 LBS BALLAST</u>	<u>MOM/100 (in/lb_f)</u>	<u>% c.g. SHIFT AFT</u>
N6014M	1690.0 lbs	1945	2.7%
N60171	1625.0 lbs	1855	2.7%
N18325	1680.5 lbs	1959	2.8%

Kent R. Crenshaw
KENT R. CRENSHAW, Maj, USAF
Aero 495 Course Director

APPENDIX F

Flight Test Planing Guide Sundowner 180 C23 Limited Flying Qualities Evaluation

AERO 495 FLIGHT TEST TECHNIQUES

FLIGHT TEST PLANNING GUIDE

SUNDOWNER C23 LIMITED FLYING QUALITIES EVALUATION

MAJ CRENSHAW

FEBRUARY 1983

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Flight 4 - Dynamic Stability; Stalls	7
References	14

REPRODUCED ON USIA FORM

FLIGHT 3

Longitudinal and Lateral-Directional Stability and Control; Maneuvering Flight

I. OBJECTIVES

- A. Measure the slope and linearity of the longitudinal stick force and elevator displacement curves.
- B. Determine the stick-fixed and stick-free neutral points.
- C. Determine the stick-fixed and stick-free maneuver points.
- D. Measure the slope and linearity of the rudder pedal force and displacement versus sideslip.
- E. Evaluate the turn coordination of the aircraft.

II. AIRCRAFT

Beechcraft Sundowner 180 C23

III. LIMITATIONS

As specified in the test plan.

IV. MISSION EVENTS

A. Pilot

1. Make a Flight Manual, no flap takeoff.
2. Stabilize the aircraft in level flight at a selected test altitude of either 8,000 or 9,000 feet.
3. Trim the aircraft for either 80 or 90 KIAS. Lean the engine for best cruise.
4. From the trim airspeed, use the stabilized test technique and vary airspeed $\pm 15\%$, staying within $\pm 1,000$ feet of the test altitude.
5. From the trim airspeed, use the stabilized test technique and vary load factor up to and including ± 2.0 "g's" while descending to maintain constant airspeed. Stay within $\pm 1,000$ feet of the test altitude. Perform the test in both directions.
6. Perform steady sideslips at various sideslip angles up to maximum sideslip in both directions. Maximum sideslip duration will not exceed 30 seconds.
7. Stabilize the aircraft in 45° bank turns in both directions at the trim airspeed and test altitude.
8. Make normal full stop landing.

B. Students

- roll.
 1. Compute take-off weight, center of gravity and predicted take-off
 2. Record the data required on the attached data sheets.
 3. Record both pre-flight and post-flight aircraft tach time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce the data using the attached data reduction sheets.

B. Plot:

1. Stick deflection δ_e and stick force F_e versus indicated airspeed V_i for longitudinal static stability test points.
2. Stick deflection δ_e and F_e/q versus lift coefficient C_L .
3. Stick deflection δ_e and stick force F_e versus load factor n .
4. Rudder deflection δ_R and rudder force F_R versus sideslip angle β .
5. Bank angle ϕ , aileron deflection δ_a and stick force F_e versus β .

C. Using data from other flights (if available) with forward and aft centers of gravity, determine the following:

1. Stick-fixed and stick-free neutral points.
2. Stick-fixed and stick-free maneuver points.
3. Compare these points to the forward and aft center of gravity limits in the flight manual.

D. Evaluate the aircraft against the following paragraphs of MIL-F-8785C:

- 3.2.1.1 Longitudinal Static Stability
- 3.2.2.2 Control Feel and Stability in Maneuvering Flight
- 3.2.2.2.1 Control Forces in Maneuvering Flight
- 3.2.2.2.2 Control Motions in Maneuvering Flight
- 3.3.2.6 Turn Coordination
- 3.2.3.7 Longitudinal Control in Sideslip
- 3.3.6.1 Yawing Moments in Steady Sideslips
- 3.3.6.2 Side Forces in Steady Sideslips
- 3.3.6.3 Rolling Moments in Steady Sideslips

E. Complete the "Initial Flight Test Report".

F. Complete a set of sample calculations.

G. Turn in the "Initial Flight Test Report", MIL-F-8785C evaluation results, recorded data sheets, data reduction sheets, sample calculations and plots using the format specified in the "Guidelines for Flight Reports" handout.

FLIGHT 3 DATA RECORD

Page 1

DATE _____ TAKEOFF DATA: FIELD ELEVATION - 6,172 FEET

INSTRUCTOR _____ ALTIMETER _____

STUDENTS: OBSERVER - _____ WINDS _____

RECORDER - _____ PRESS. ALT. _____

AIRCRAFT NU. N- _____ TEMP. _____

PRE-FLIGHT TACH TIME _____ GD ROLL (P) _____

REMARKS: _____ FUEL _____ OIL _____

POST-FLIGHT TACH TIME _____

LONGITUDINAL STATIC STABILITY

Trim Conditions: (RUN 1)				Trim Conditions: (RUN 2)				Trim Conditions: (Right Turn)				Trim Conditions: (Left Turn)			
V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)	V _i (KTS)
H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)	H _i (FT)
T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)	T _i (°C)
Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time	Tach Time
MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM	MAP/RPM

V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)	V _{aim} (KTS)
δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)	δ _e (IN)
F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)	F _e (lb _f)
V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}
V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}	V _{trim}

REMARKS:

REMARKS:

REMARKS:

FLIGHT 3 DATA RECORD

PAGE 2

LATERAL-DIRECTIONAL STATIC STABILITY												
Trim Conditions:		Remarks:										
V _i (KTS)												
H _i (FT)												
T _i (°C)												
δ _R (IN)												
Tach Time												
MAP/RPM												
β _{aim}	β = 0	-2°	-4°	-6°	-8°	-10°	0	+2°	+4°	+6°	+8°	+10°
β (deg)												
φ (deg)												
δ _R (in)												
* δ _a (left)												
* δ _a (right)												
F _R (right)												
F _R (left)												
F _e (lb _f)												
Turn Coordination: θ = 45°												
Right: F _e (lb _f)		F _R (lb _f)										
Left: F _e (lb _f)		F _R (lb _f)										
Remarks:												

NOTF. Plot data as recorded. No data reduction required.

*In case 1/8, 1/4, 1/2 deflection, etc.

Aircraft, Sundowner 180 C23 Wing Area: S = 146 ft²

[illegible]1. V_i (KTS) indicated airspeed.

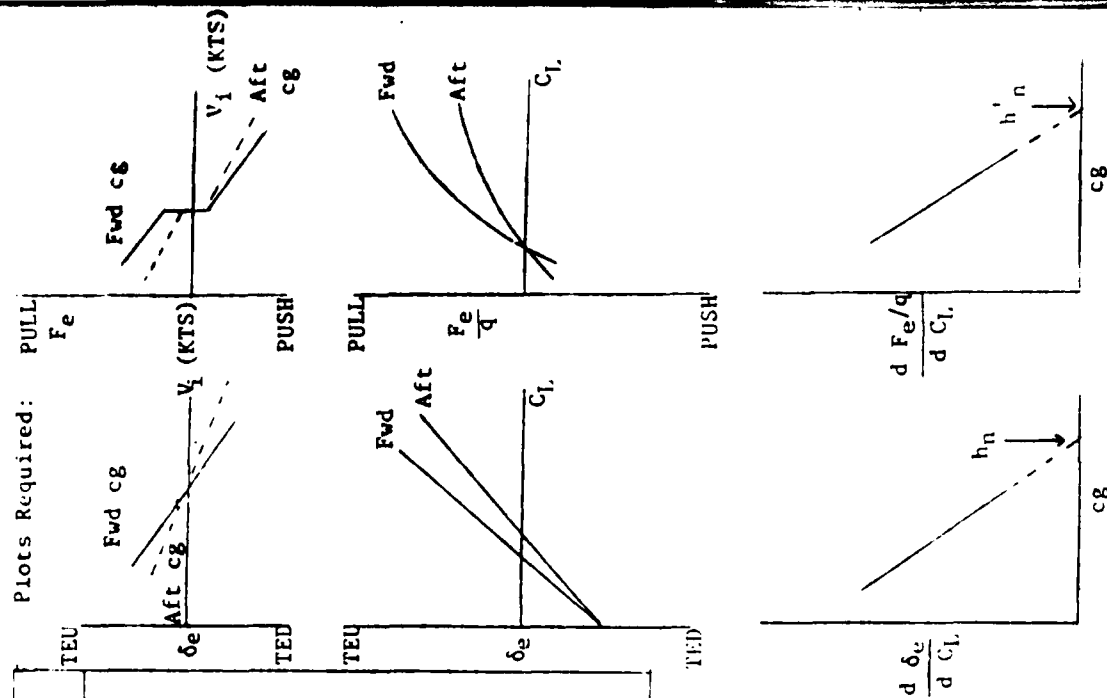
2. V_c (KTS) $\approx V_e$ (KTS) equivalent airspeed, p. 5-10 F.M.

$$3. \quad q = 1200 \, v_e^2 = \frac{0.002377}{2} (\textcircled{2} \times 1.69)^2$$

$$4. \quad C_L = \frac{W}{1.400 V_c^2 S} = \frac{W}{qS} = \frac{W}{\textcircled{3} S}$$

5. δ_e (inches) Stick displacement in inches6. F_e (lb) Elevator force in pounds.

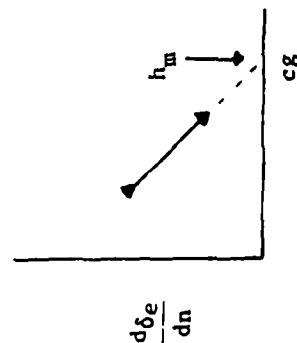
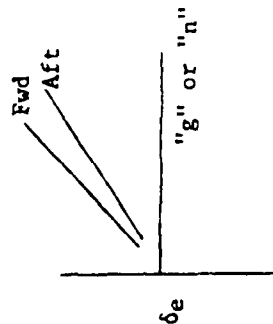
$$7. \quad F_c/q = \frac{(6)}{(1)}$$



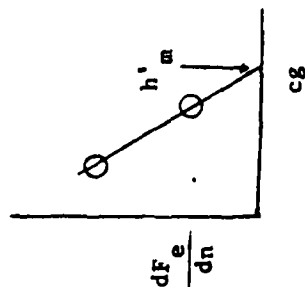
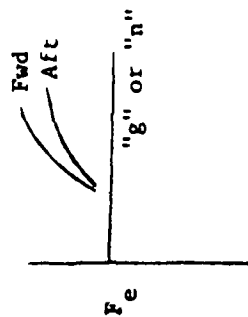
Aircraft, Sundowner 180 C23				
1	2	3	4	5
c.g.	V ₁ (KTS)	δ_e (inches)	F _e (lb)	"g"

1. C_g in % MAC.
2. V_i indicated airspeed.
3. δ_e (1a) Stick displacement in inches
4. P_e (1b) Elevator forces in lb.
5. "g" direct reading off gauge.

Wing Area: $S = 146 \text{ ft}^2$



Stick-fixed maneuvering



Stick-free maneuvering

FLIGHT 4

DYNAMIC STABILITY; STALLS

I. OBJECTIVES

- A. Determine the lateral control power of the aircraft.
- B. Measure the short period, phugoid, Dutch roll and spiral characteristics of the aircraft.
- C. Observe the aircraft stall characteristics to include stall warning and verify the $1g$ stall speeds given in the Flight Manual.

II. AIRCRAFT

Beechcraft Sundowner 180 C23

III. LIMITATIONS

As specified in the test plan.

IV. MISSION EVENTS

A. Pilot

1. Make a no flap, Flight Manual takeoff.
2. Stabilize the aircraft in level flight at a selected altitude and trim airspeed for the first tests to be performed.
3. For stalls, trim the aircraft for $1.2 V_g$ at a minimum altitude of 8,500 ft MSL. Using the curved flight path method, leave the throttle at the trim setting and use pitch to achieve a bleed rate of 1 to 2 knots per second. The aircraft should stall within ± 500 feet of the desired stall altitude. Initiate recovery when:
 - a. a definite g-break occurs.
 - b. a rapid, uncommanded angular motion develops.
 - c. the aft stick stop has been reached and pitch attitude cannot be increased.
 - d. sustained heavy buffet develops.
4. Stabilize the aircraft in level flight at one selected altitude and trim airspeed for all remaining tests.
5. For the lateral control power evaluation, perform aileron rolls from 45° to 45° of bank with $\frac{1}{2}$ and full control wheel deflection. This test should be done in both directions with the rudder fixed.
6. For the dynamic tests, use the following techniques:

- a. Short Period - Pump the elevator using sinusoidal ramp inputs of $\pm .5$ "g" until the aircraft response is in phase with the elevator input. Release the control wheel at the trim position. Use small rudder inputs to maintain wings level.
- b. Phugoid - From the trim condition, perturb the airspeed by 15 knots and return the control wheel back to the trim position and release. Again, use small rudder inputs to maintain wings level.
- c. Dutch Roll - From the trim condition, perturb the aircraft using sinusoidal ramp inputs of $\frac{1}{2}$ rudder deflection, then return the rudder to neutral and release.
- d. Spiral - Stabilize the aircraft in a coordinated left or right turn at a 20° bank angle. Neutralize the aileron control and release. Perform the test in both directions. Time for 20 seconds.

B. Students

1. Compute take-off weight, center of gravity and predicted takeoff ground roll.
2. Record the information shown on the attached data record sheets for each test performed.
3. Record both pre-flight and post-flight each time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce data where required using the attached data reduction sheets. Use a standard weight of 2,450 lbs for analyzing stall speeds.

B. Plot

1. ϕ versus time.
2. V_1 versus time for the phugoid dynamic mode.

C. Using the plots above where appropriate and other test data, determine the following:

1. 1 "g" indicated stall speed for a standard weight of 2,450 lb_f and compare with the Flight Manual.
2. For the phugoid dynamic mode, determine the period, T , the damping ratio, ξ , time to half amplitude, $t_{\frac{1}{2}}$, actual frequency, ω_D , and the undamped natural frequency, ω_n . Use the log decrement method with your plotted data. Compare your flight test, ω_n , with the approximation equation for ω_n .
3. Report the time to double, t_2 , or time to half, $t_{\frac{1}{2}}$, bank angle for the spiral dynamic mode.

4. Determine the period, T , actual frequency, ω_D , estimate the damping and find the undamped natural frequency of the Dutch Roll oscillation.

5. Report the time to roll through 60° of bank. Find the roll mode time constant.

D. Evaluate the aircraft against the following paragraphs of MIL-F-8785C:

1. Dynamic Stability:

- 3.2.1.2 Phugoid Stability
- 3.2.2.1 Short Period Response
- 3.3.1.1 Lateral-Directional Oscillations (Dutch Roll)
- 3.3.1.2 Roll Mode
- 3.3.1.3 Spiral Stability
- 3.3.4 Roll Control Effectiveness
- 3.3.4.5 Wheel Control Throw
- 3.3.2.5 Control of Sideslip in Rolls

2. High AOA Tests:

- 3.4.2.1.1 Stalls Approach
- 3.4.2.1.1.1 Warning Speed for Stalls at $1g$ Normal to the Flight Path
- 3.4.2.1.2 Stall Characteristics
- 3.4.2.1.3 Stall Prevention and Recovery

E. Complete the "Initial Flight Test Report".

F. Complete a set of sample calculations.

G. Turn in the "Initial Flight Test Report", MIL-F-8785C evaluation results, recorded data sheets, data reduction sheets, sample calculations, and plots using the format specified in the "Guidelines for Flight Reports" handout.

DATE _____

INSTRUCTOR

WINDS

PRESS. ALT.

AIRCRAFT NU. N-

GD ROLL (P)

FUEL OIL

LATERAL CONTROL POWER

STALL TESTING

Trim Conditions:

$$11_i \quad (1.1)$$

Tach Time

MAP/KPM

Time Co
 $\Delta\phi = 60^\circ$

67

Time Co
 $\Delta\phi = 60^\circ$ $\Delta\phi = 60^\circ$ H_i (horn)

$V_i(\text{buffet})$	$H_i(\text{buffet})$
----------------------	----------------------

V_i (stall)	H_i (stall)
---------------	---------------

Alt. Loss in Recovery	Bleed Rate
0.00	0.00
0.05	0.05
0.10	0.10
0.15	0.15
0.20	0.20
0.25	0.25
0.30	0.30
0.35	0.35
0.40	0.40
0.45	0.45
0.50	0.50
0.55	0.55
0.60	0.60
0.65	0.65
0.70	0.70
0.75	0.75
0.80	0.80
0.85	0.85
0.90	0.90
0.95	0.95
1.00	1.00

Remarks:

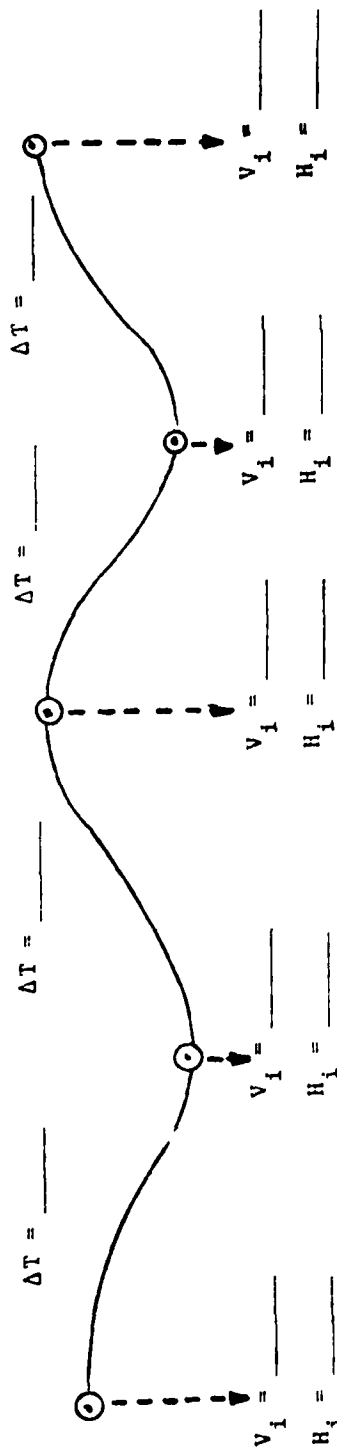
Remarks:

AIRCRAFT DYNAMICS

Trim Conditions: V_i (KTS) _____ H_i (FT) _____ T_i (°C) _____
 Tach Time _____ MAP/RPM _____

Short Period Damping _____ O/S _____ Time _____
 Remarks: _____

Phugoid



Remarks: Record V_i and H_i each time VVI passes zero.

Dutch Roll

Damping _____ O/S _____ Time _____
 ϕ/B _____

Remarks: _____

Spiral (Left) _____ ° ϕ to _____ ° ϕ SCCS
 (Right) _____ ° ϕ to _____ ° ϕ SCCS

Remarks: _____

Aircraft, Sundowner 180 C23

Wing Area = 146 ft²

①	②	* ③	* ④	* ⑤	* ⑥
δ_a (R)	δ_a (L)	τ (sec) (L)	τ (sec) (R)	θ (deg) (L)	θ (deg) (R)

***Use tape recorder to get these. Recommend in-flight handwritten record as a backup.**

1. δ_a (R) Right aileron deflection
2. δ_a (L) Left aileron deflection
3. Successive time to roll $\Delta\theta = 90^\circ$ to the left
4. Successive time to roll $\Delta\theta = 90^\circ$ to the right
5. Successive bank angle ϕ to the left
6. Successive bank angle ϕ to the right
7. Plot ϕ versus t for both left and right turn for each δ_a tested

①	②	③	④	⑤	⑥
H_{pi}	V_i	V_e	W_t	C_L	V_{Iw}

1. H_{pi} (ft) Indicated pressure altitude
2. V_i (Kts) Indicated airspeed
3. V_c (Kts) $\approx V_e$ (Kts) Equivalent airspeed; P. 5-10 F.M.
4. W_t (lbs) Aircraft test weight: empty weight + fuel + people
5. $C_L = \frac{2W}{\rho V^2 S} = \frac{2 \times (4)}{\rho V^2 S} = .002377 (3 \times 1.689)^2 S$
where S is wing area.
6. Calculate C_L for each speed
7. $V_{iw} = (3) \sqrt{\frac{W}{4}}$
($W_s = 2,450$ lbs)

NOTE: Do this for speed where horn comes on, buffet speed and stall speed.

REFERENCES

1. Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for the Beechcraft Sundowner 180 C23, Beech Aircraft Corporation, Wichita, Kansas, August 1980.
2. Military Specification, Flying Qualities of Piloted Airplanes, Department of the Air Force, Washington, D.C., MIL-F-8785C, 5 November 1980.
3. Roberts, Sean C., Flying Qualities Flight Testing of Light Aircraft for Test Pilots and Flight Test Engineers, Flight Research, Inc., Mojave, California, September 1981.
4. Military Specifications, Stall/Post-Stall/Spin Flight Test Demonstration Requirements for Airplanes, Department of the Air Force, Washington, D.C., MIL-S-83691A (USAF), 15 April 1972.

REPRODUCED ON USAF FORM 10

INITIAL FLIGHT TEST REPORT		1. AIRCRAFT TYPE	2. SERIAL NUMBER
3. CONDITIONS RELATIVE TO TEST			
a. DATE:	e. CONFIGURATION:	i. FUEL LOAD:	
b. PILOT:	f. INSTRUMENTATION:	j. SURFACE WIND:	
c. OBSERVERS:	g. START UP GR WT:	k. WEATHER:	
d. SORTIE TIME/T.O. TIME:	h. START UP C.G.:	l. GROUND BLOCK:	
4. TESTS PERFORMED			
5. RESULTS OF TESTS (Continue on reverse side if needed)			
6. REMARKS (Continue on reverse side if needed)			

REPRODUCTION OF THIS FORM IS PROHIBITED

Reference: AFFIC Form 353 APR '74

F-18

INITIAL FLIGHT TEST REPORT		1. AIRCRAFT TYPE	2. SERIAL NUMBER
3. CONDITIONS RELATIVE TO TEST			
a. DATE:	e. CONFIGURATION:	i. FUEL LOAD:	
b. PILOT:	f. INSTRUMENTATION:	j. SURFACE WIND:	
c. OBSERVERS:	g. START UP GR WT:	k. WEATHER:	
d. SORTIE TIME/T.O. TIME:	h. START UP C.G.:	l. GROUND BLOCK:	
4. TESTS PERFORMED			
5. RESULTS OF TESTS (Continue on reverse side if needed)			
6. REMARKS (Continue on reverse side if needed)			

Reference: AFFTC Form 365 APR '74

APPENDIX G

Sample Flying Qualities Data Records, Data Reduction and Plots

Contents

	<u>Page</u>
Flight 3 - Longitudinal and Lateral-Directional Stability and Control; Maneuvering Flight	G-3
Flight 4 - Dynamic Stability; Stalls	G-17

TAKEOFF DATA: FIELD ELEVATION - 6,172 FEET

ALTINETER 30.09

WINDS 140/8 knots

PRESS. ALT. 6000 feet

TEMP. 36.5

C/D ROLL (P) 1700 feet

COMMENT: Aircraft flown with 50 lb weight in baggage compartment in order to obtain data with aft center of gravity

MANEUVERING STABILITY

Trim Conditions: (RUN 1)						Trim Conditions: (RUN 2)						Trim Conditions: (Right Turn)						Trim Conditions: (Left Turn)					
V _i (KTS)		δ _e (IN)		*F _e (lb _f)		V _i (KTS)		δ _e (IN)		*F _e (lb _f)		V _i (KTS)		δ _e (IN)		*F _e (lb _f)		V _i (KTS)		δ _e (IN)		*F _e (lb _f)	
90		7		0		90		7		0		90		7 1/2		0		90		7 1/2		0	
85		7 3/16		.015		90		7 3/16		.06		90		7 3/16		.18		90		7 3/16		.18	
80		7 1/4		.49		90		7 1/4		.55		90		7 1/4		.81		90		7 1/4		.81	
75		7 1/16		.75		90		7 1/16		2.63		90		7 1/16		Max		90		7 1/16		Max	
90		7		0		90		7		0		90		7 1/2		0		90		7 1/2		0	
95		6 15/16		0		90		6 15/16		0		90		6 15/16		0		90		6 15/16		0	
100		6 3/4		.05		90		6 3/4		.05		90		6 3/4		.05		90		6 3/4		.05	
105		6 3/4		.38		90		6 3/4		.38		90		6 3/4		.38		90		6 3/4		.38	
*Values converted to force using calibration curve						*Values converted to force using calibration curve						*Values converted to force using calibration curve						*Values converted to force using calibration curve					

FLIGHT 3 DATA RECORD

PAGE 2

LATERAL-DIRECTIONAL STATIC STABILITY													
Trim Conditions:				Remarks: <i>Started at 8500 ft to stay within 1500 ft of 8000 ft. Mission flown 2 Dec '82 in NG014M.</i>									
V_1 (KTS) <u>90</u>				Turn Coordination: $\theta = 45^\circ$									
H_1 (FT) <u>8000</u>				Right: F_e (lb _f) <u>7</u> F_R (lb _f) <u>7</u>									
T_1 (°C) <u>-1</u>				Left: F_e (lb _f) <u>7</u> F_R (lb _f) <u>0</u>									
δ_R (IN) <u>16 1/8</u>				Remarks:									
Tach Time <u>1324.87</u>													
MAP/RPM <u>2400</u>													
β_{aim}	$\beta = 5^\circ$	-5°	-10°	-15°	-20°	-25°	-30°	-35°	-40°	-45°	-50°	-55°	-60°
β (deg)	"	"	"	"	"	"	"	"	"	"	"	"	"
θ (deg)	-2	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
δ_R (in)	16 3/8	16 5/8	16 7/8	17 1/8	17 3/8	17 5/8	17 7/8	18 1/8	18 3/8	18 5/8	18 7/8	19 1/8	19 3/8
* δ_a (left)	-1/8	-1/4	-3/8	-1/2	-5/8	-3/4	-7/8	-1	-1 1/8	-1 1/4	-1 3/8	-1 5/8	-1 7/8
* δ_a (right)													
F_R (right) (lb _f)	15.5	20	24	27									
F_R (left) (lb _f)	0	0	0	0									
F_e (lb _f)	0	0	0	0									

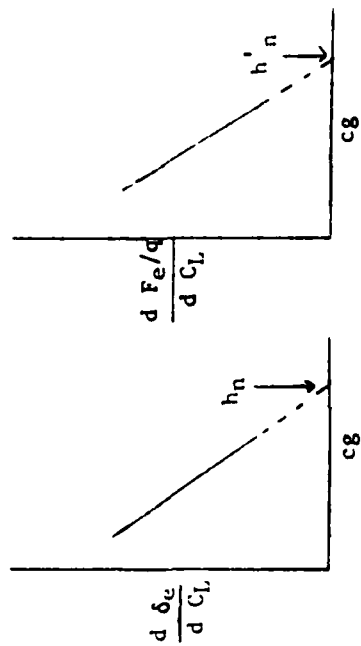
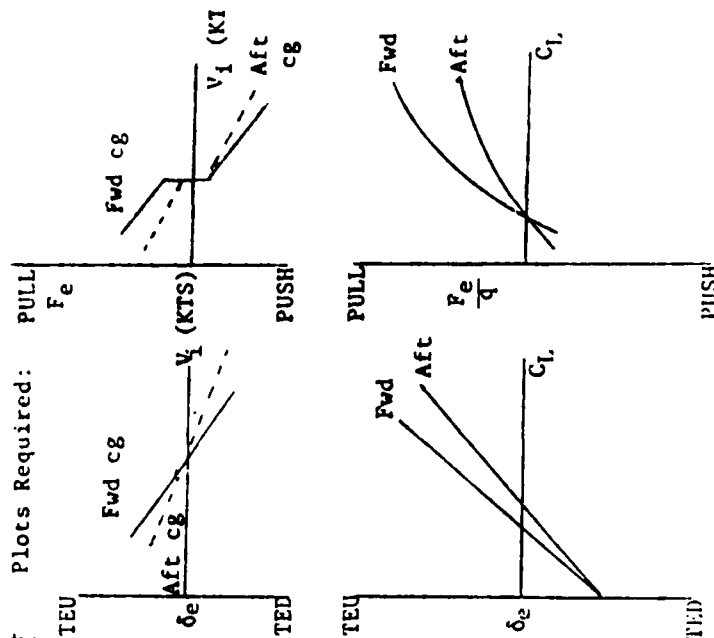
NOTF. Plot data as recorded. No data reduction required.
*Indicate 1/8, 1/4, 1/2 deflection, etc.

LONGITUDINAL STATIC STABILITY DATA REDUCTION

Aircraft, Sundowner 180 C23 Wing Area: $S = 156 \text{ ft}^2$

1	2	3	4	5	6	7
V_i (KTS)	V_e (KTS)	q (psf)	C_L	δ_e (inches)	F_e (lb)	F_e/q
75	75	19.1	.88	7.44	6.6	.35
80	79	21.2	.80	7.25	5.5	.26
85	84	24.0	.70	7.19	0	0
90	89	26.9	.63	7.00	0	0
95	94	30.0	.56	6.94	0	0
100	99	33.3	.51	6.81	8.5	.08
105	104	36.7	.46	6.75	5.0	.14

Pull Trim Push



1. V_i (KTS) indicated airspeed.
2. V_e (KTS) $\approx V_e$ (KTS) equivalent airspeed, p. 5-10 F.M.

$$3. q = \frac{1}{2} \rho V_e^2 = \frac{0.002377}{2} (2 \times 1.69)^2$$

$$4. C_L = \frac{W}{\frac{1}{2} \rho V_e^2 S} = \frac{W}{qS} = \frac{W}{qS} \quad (3)$$

5. δ_e (inches) Stick displacement in inches
6. F_e (lb) Elevator force in pounds.

$$7. F_e/q = \frac{(6)}{(3)}$$

LONGITUDINAL MANEUVERING STABILITY DATA REDUCTION

Aircraft, Sundowner 180 C23

Wing Area: $S = 146 \text{ ft}^2$

c.g.	V_i (KTS)	δ_e (inches)	F_e (lb)	"g"	$\frac{d\delta_e}{dn}$
24.2	90	7.00	0	1.0	
24.2	90	7.31	2.5	1.2	
24.2	90	7.63	5.75	1.4	
24.2	90	8.38	15.00	1.8	
24.2	90	7.03	0	1.0	
24.2	90	7.28	4.2	1.2	
24.2	90	7.63	6.7	1.4	
24.2	90	8.50	15.00	2.0	

Right Turn Left Turn

1. Cg in Z MAC.

2. V_i indicated airspeed.

3. δ_e (in) Stick displacement in inches

4. F_e (lb) Elevator forces in lb.

5. "g" direct reading off gauge.

Stick-fixed maneuvering

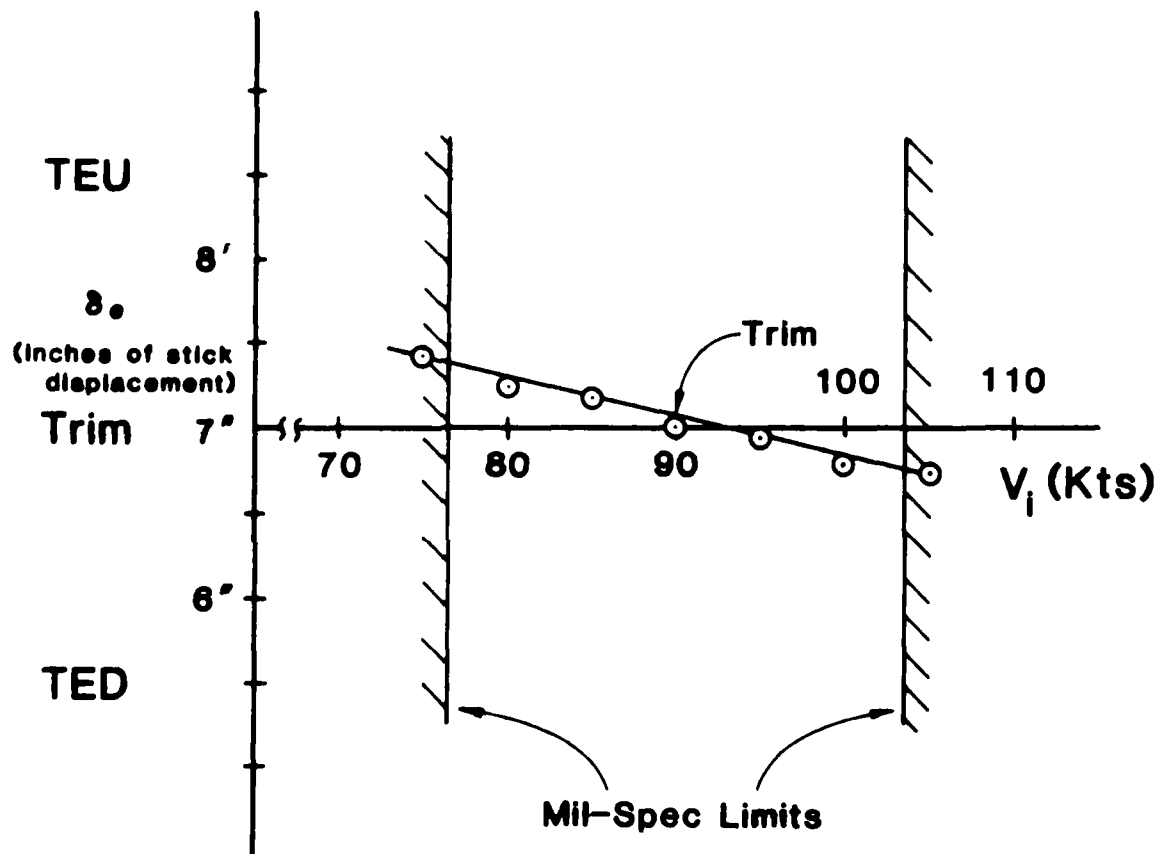
Stick-free maneuvering

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_i = 90$ kts

24% CG

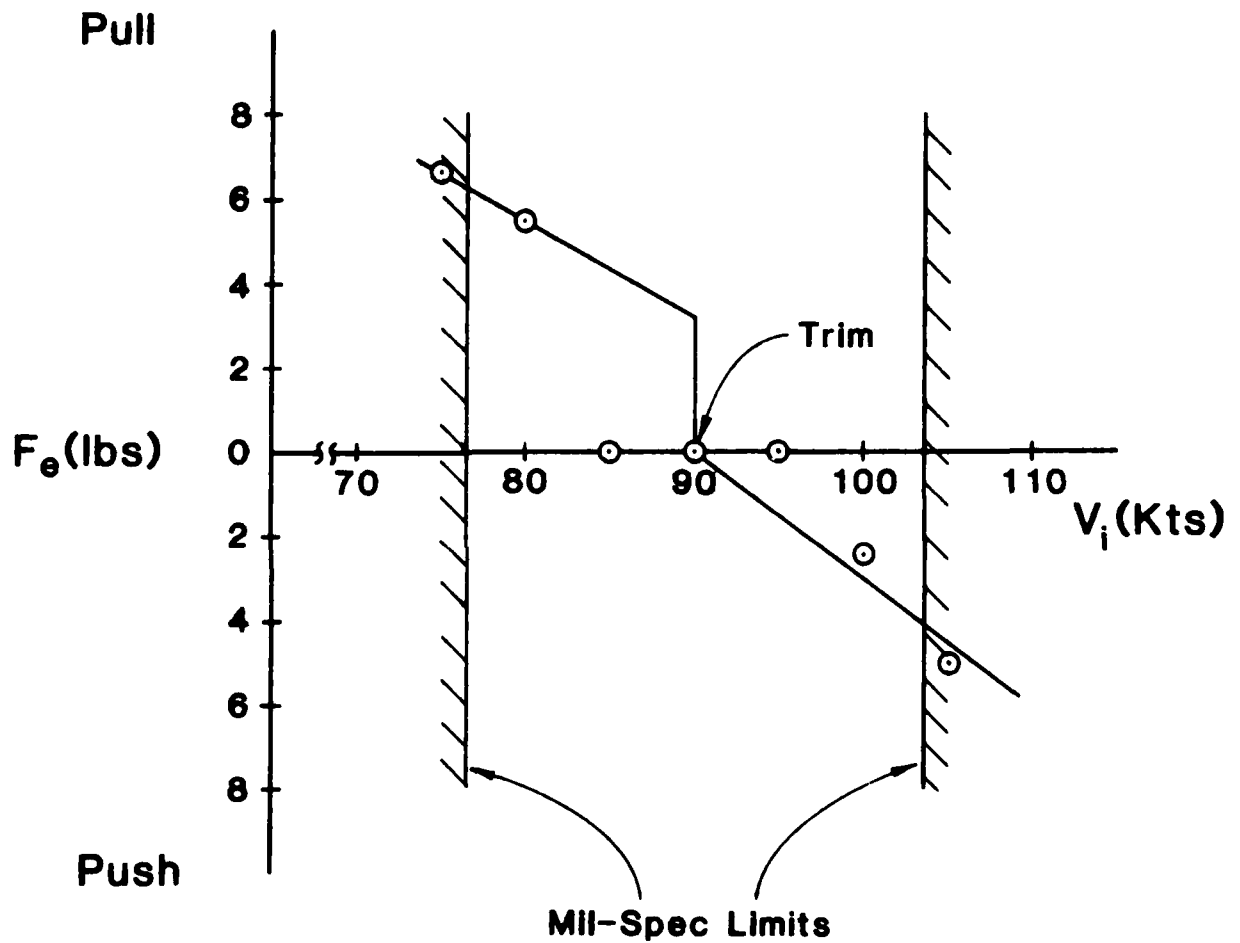


Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_i=90$ kts

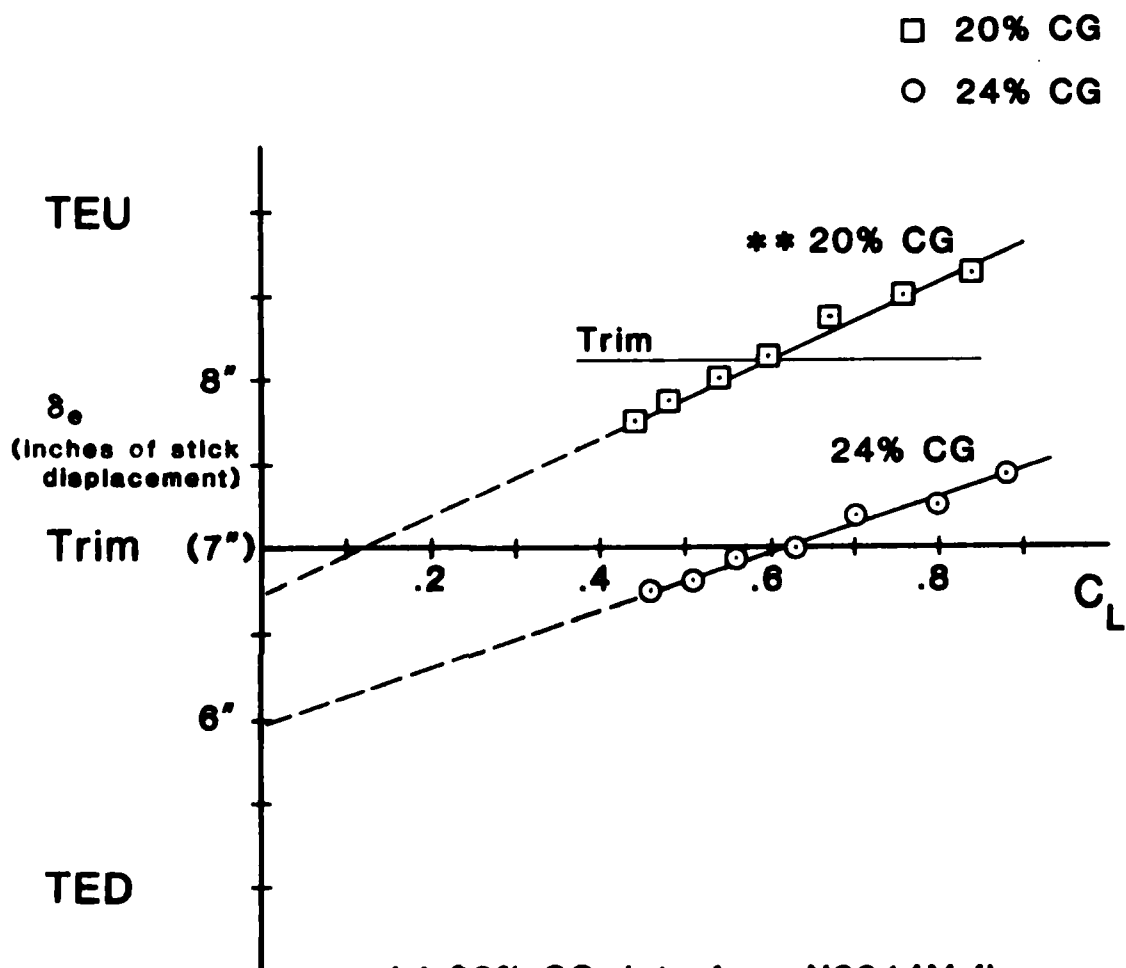
24% CG



Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$ kts 24% CG

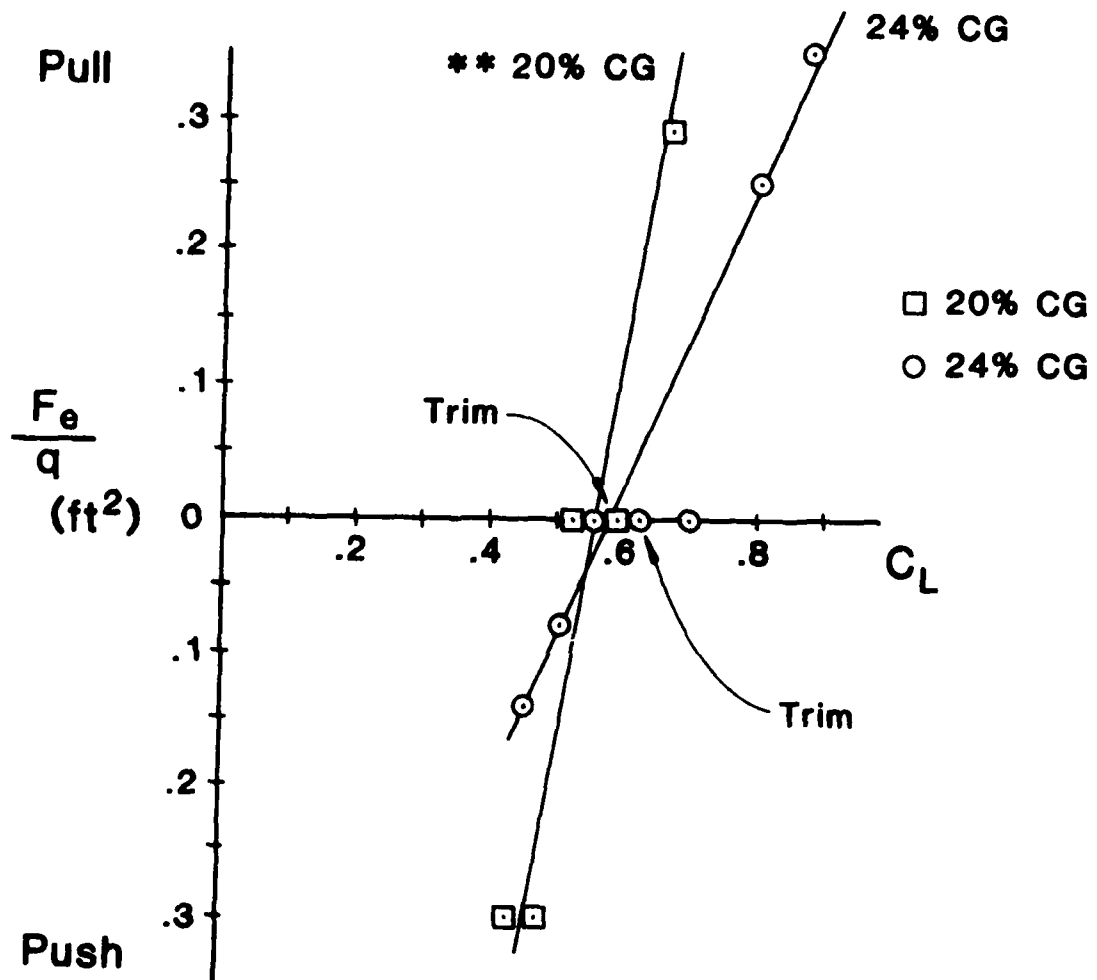


** 20% CG data from N6014M flown
on 1 Nov at 8,000 feet and 90 kts

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_i = 90$ kts 24% CG



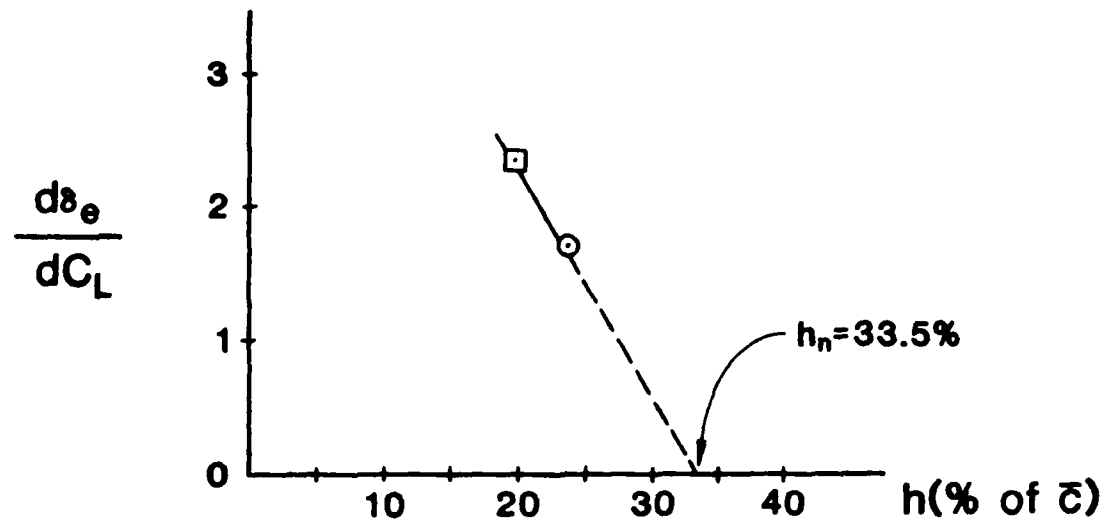
** 20% CG data from N6014M flown
on 1 Nov at 8,000 feet and 90 kts

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

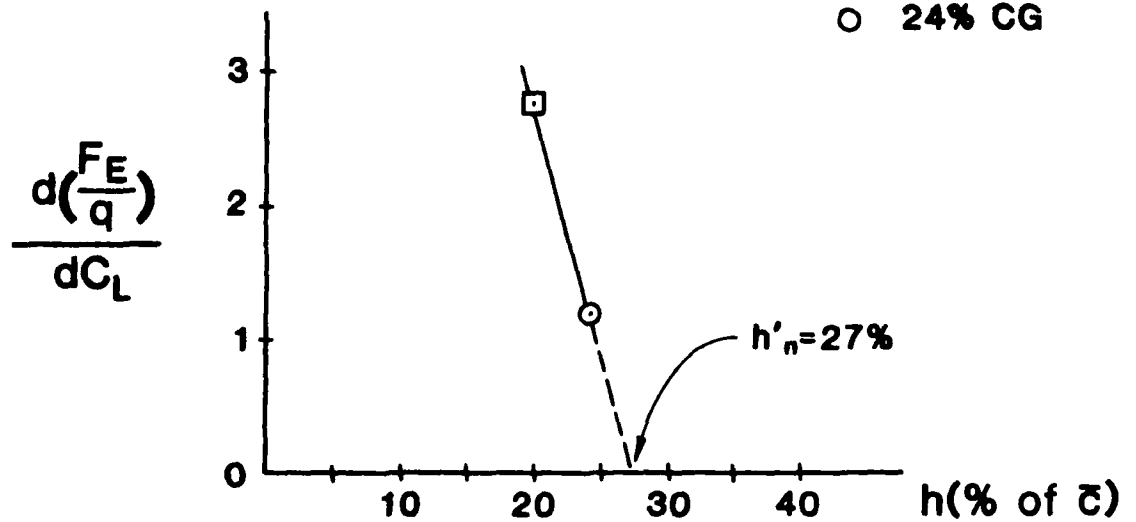
$V_i=90$ kts

24% CG



□ 20% CG

○ 24% CG

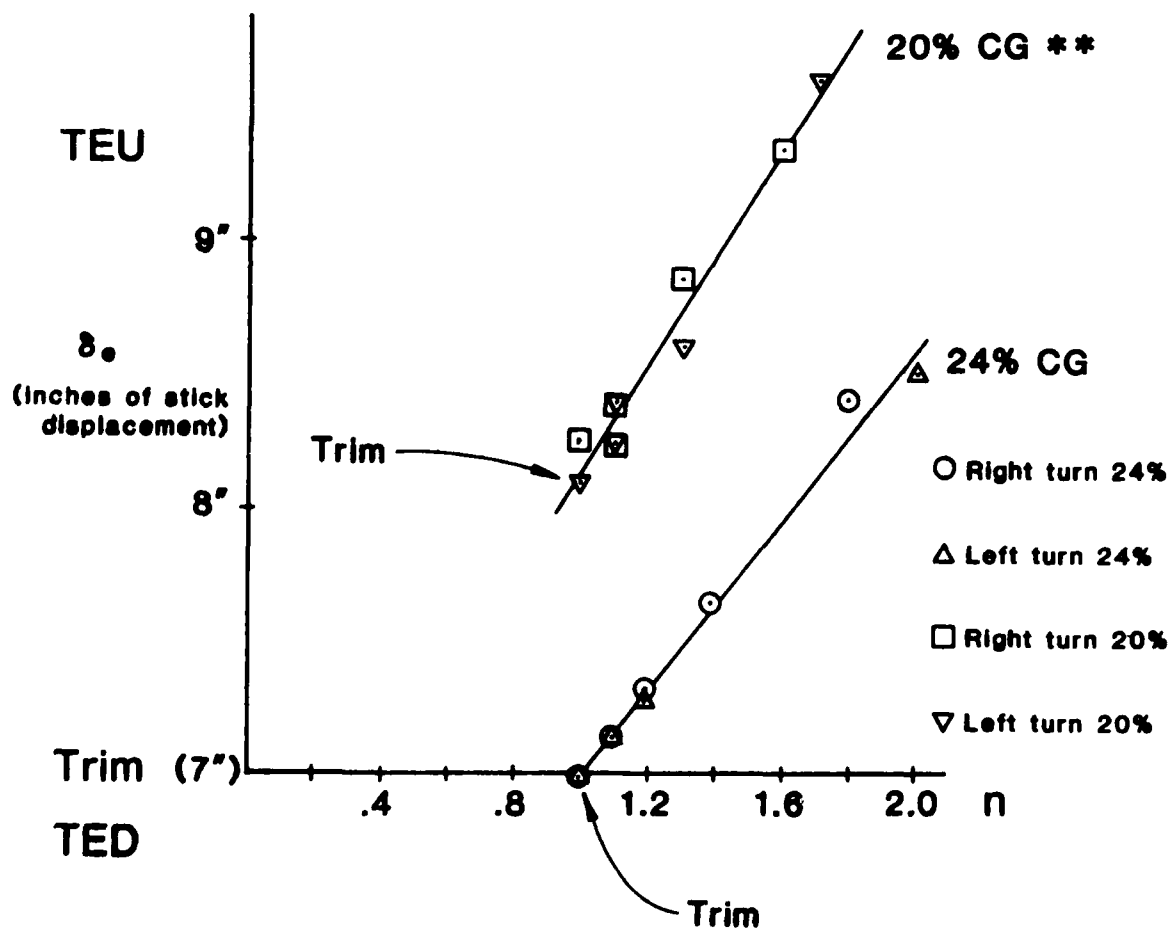


Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$ kts

24% CG



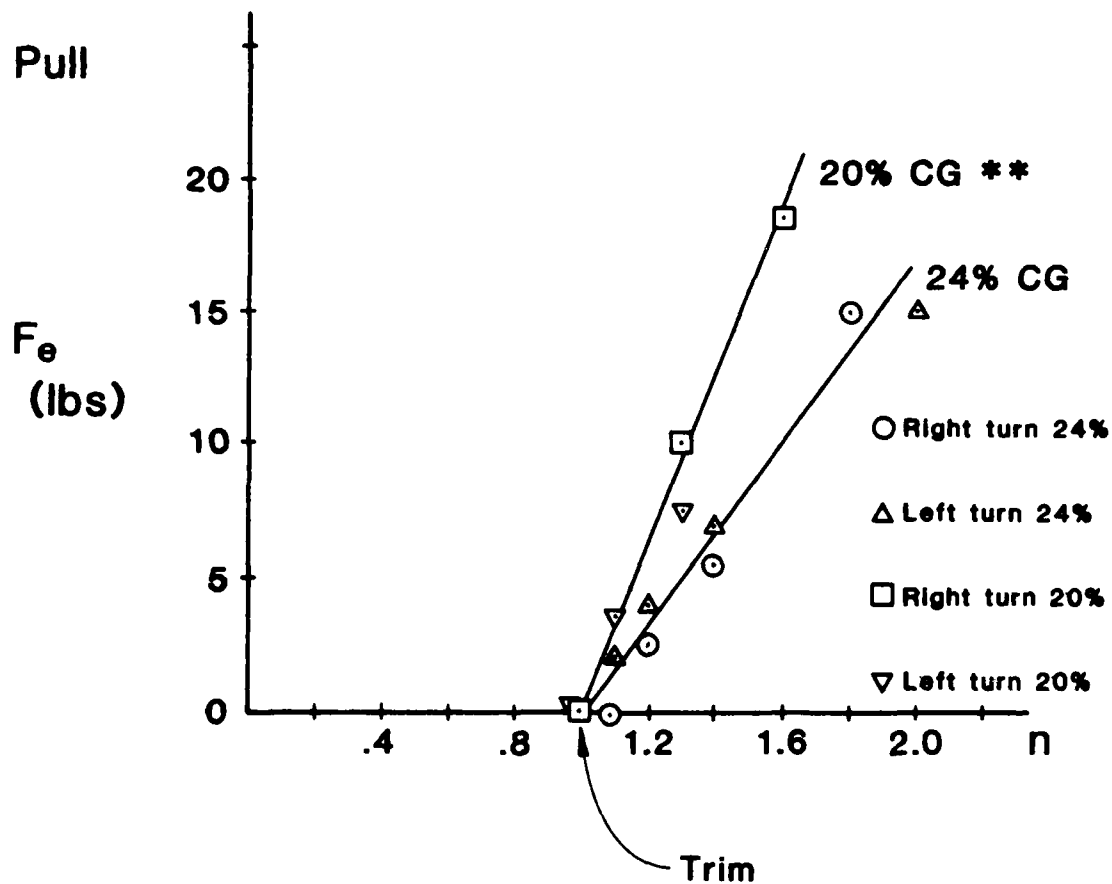
** 20% CG data from N6014M flown on 1 Nov at 8,000 feet and 90 kts

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_i = 90$ kts

24% CG



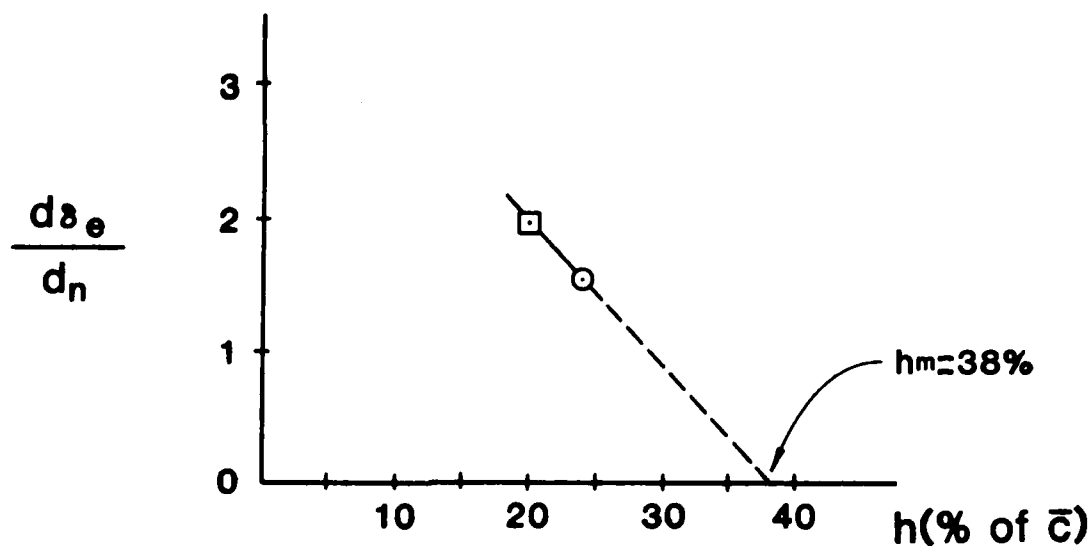
** 20% CG data from N6014M flown
on 1 Nov at 8,000 feet and 90 kts

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

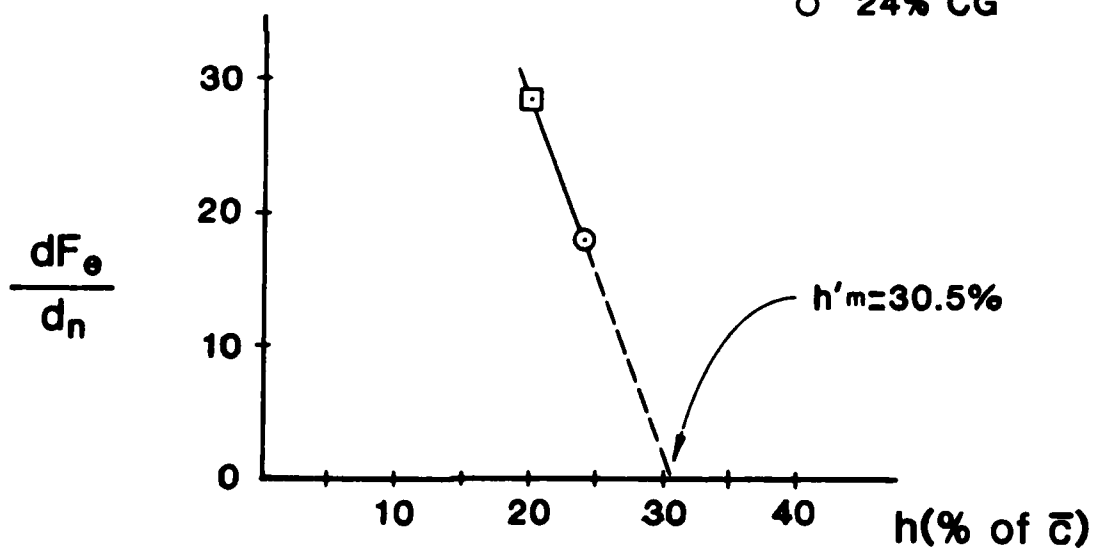
$V_i=90$ kts

24% CG



□ 20% CG

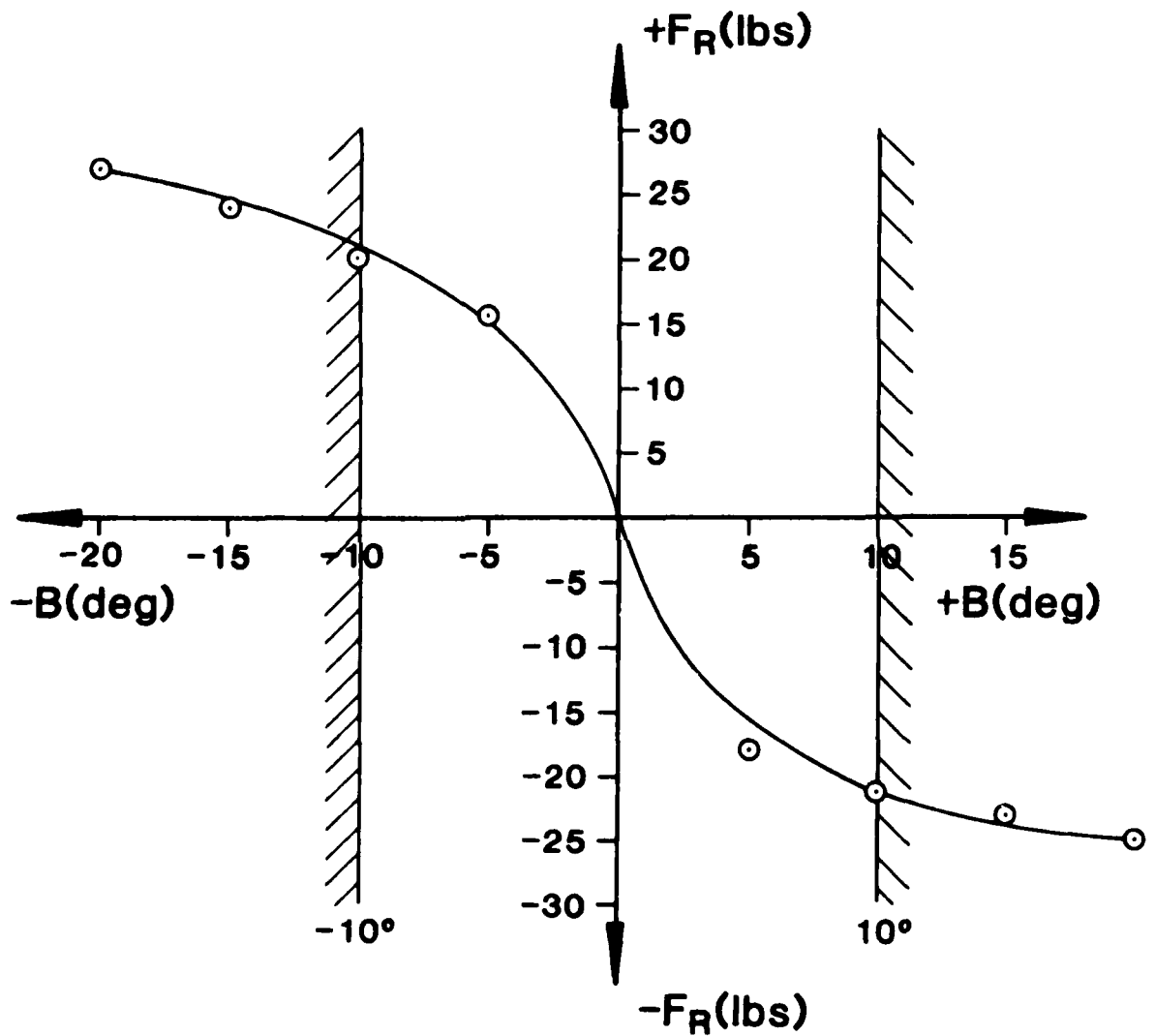
○ 24% CG



Rudder Force (F_R) vs Sideslip Angle (B)

Beechcraft Sundowner 180

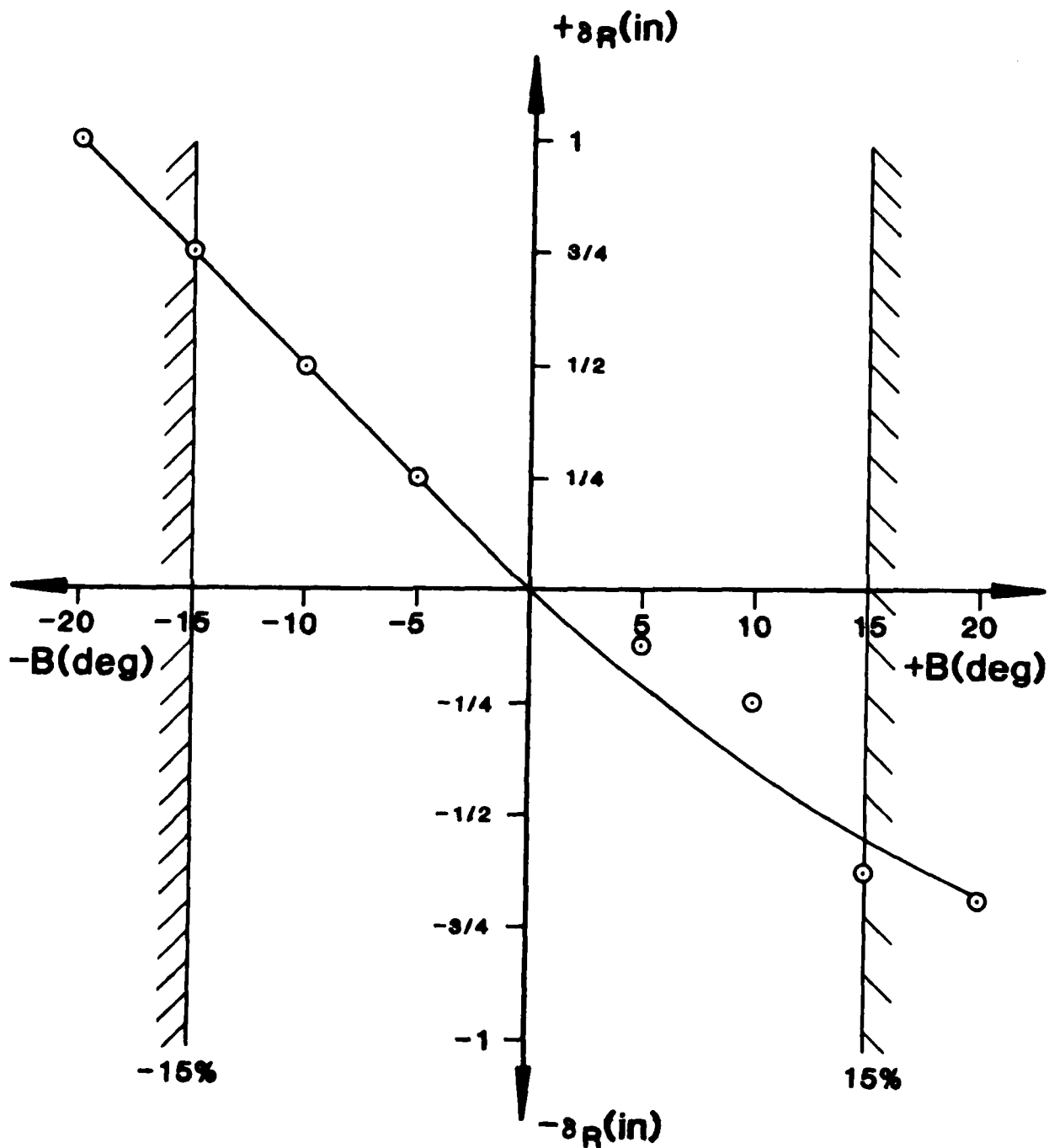
Test Alt=8,000 feet $V_I=90$ kts



Rudder Deflection (δ_R) vs Sideslip Angle (B)

Beechcraft Sundowner 180

Test Alt=8,000 feet $V_i=90$ kts



FLIGHT 4 DATA RECORD

Page 1

DATE 30 Nov '82
INSTRUCTOR Crenshaw
STUDENTS: OBSERVER - Nordin
RECORDER - Dingley
AIRCRAFT NU. N- 6014M
PRE-FLIGHT TACH TIME 1322.36

TAKEOFF DATA: FIELD ELEVATION - 6,172 FEET

ALTITUDE 2963

WINDS 070/6 knots

PRESS. ALT. 6350 feet

TEMP. 32°F

GD ROLL (P) 1545 feet

FUEL 57 gallons OIL 8 quarts

POST-FLIGHT TACH TIME 1323.24

REMARKS:

G-17

LATERAL CONTROL POWER

STALL TESTING

Trim Conditions
 V_i (KTS) 80 H_i (FT) 8000
 T_i (°C) +3 Tach Time 1322.89
~~MAP~~/RPM 2150

Trim Conditions:
 V_i (FT) 9000 T_i (°C) +2
Tach Time 1322.62 RPM 2200

V_i (KTS)	δ_a (L)	δ_a (R)	Total Time (sec's)	Time to $\Delta\phi = 60^\circ$ (sec's)
80		1/2	6.7	4.5
80	1/2		5.2	3.3

V_i (horn) 68 H_i (horn) 9100 ft
 V_i (buffet) 62 H_i (buffet) 9150 ft
 V_i (stall) 60 H_i (stall) 9200 ft
Alt. Loss in Recovery 175 ft Bleed Rate 2 kts/sec

REMARKS: Rolls done from 45° to 45° of bank.

Remarks: Recovery complete by 9025 ft. Stall characterized by aircraft fall off on right wing

AIRCRAFT DYNAMICS

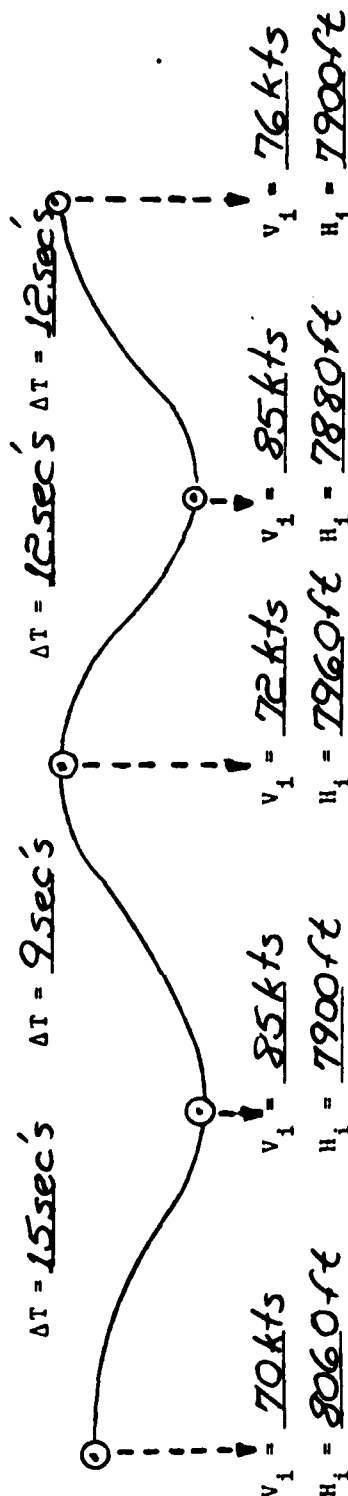
Trim Conditions: V_i (KTS) 80 H_i (FT) 8000 T_i (°C) 13

Tach Time 132300 MAP/RPM 2150

Short Period Damping >.6 O/S — Time —

Remarks: *Deadbeat*

Phugoid



Remarks: Record V_i and H_i each time VWI passes zero.

Dutch Roll

Damping -.1 O/S 6 Time 10.3 sec's

ϕ/B >1

Remarks:

Spiral (Left) 20° ϕ to 26° ϕ 20 secs
(Right) 20° ϕ to 32° ϕ 20 secs

Remarks: *Spiral stability affected by lateral center of gravity location.*

Lateral Control Power Data Reduction

Aircraft, Sundowner 180 C23

Wing Area = 146 ft²

①	②	*③	*④	*⑤	*⑥
δ_a (R)	δ_a (L)	t (sec) (L)	t (sec) (R)	θ (deg) (L)	θ (deg) (R)
1/2			1.3		25
1/2			2.3		45
1/2			3.6		65
1/2			5.2		90
	1/2	1.7		25	
	1/2	3.3		45	
	1/2	4.8		65	
	1/2	6.7		90	

*Use tape recorder to get these. Recommend in-flight handwritten record as a backup.

1. δ_a (R) Right aileron deflection
2. δ_a (L) Left aileron deflection
3. Successive time to roll $\Delta\theta = 90^\circ$ to the left
4. Successive time to roll $\Delta\theta = 90^\circ$ to the right
5. Successive bank angle θ to the left
6. Successive bank angle θ to the right
7. Plot θ versus t for both left and right turn for each δ_a tested

STALL TESTING DATA REDUCTION

①	②	③	④	⑤	⑥
H_{pi} (ft)	V_i (Kts)	V_e (Kts)	W_t (lbs)	C_L	V_{iw} (Kts)
9100 (horn)	68	69	2459	1.0434	69
9150 (buffet)	62	63	2459	1.2516	63
9200 (stall)	60	62	2459	1.2923	62

1. H_{pi} (ft) Indicated pressure altitude
2. V_i (Kts) Indicated airspeed
3. V_c (Kts) $\approx V_e$ (Kts) Equivalent airspeed; P. 5-10 F.M.
4. W_t (lbs) Aircraft test weight: empty weight + fuel + people
5. $C_L = \frac{2W}{\rho V^2 S} = \frac{2 \times ④}{.002377 (③ \times 1.689)^2 S}$
where S is wing area.
6. Calculate C_L for each speed
7. $V_{iw} = ③ \sqrt{\frac{W_s}{4}}$
($W_s = 2,450$ lbs)

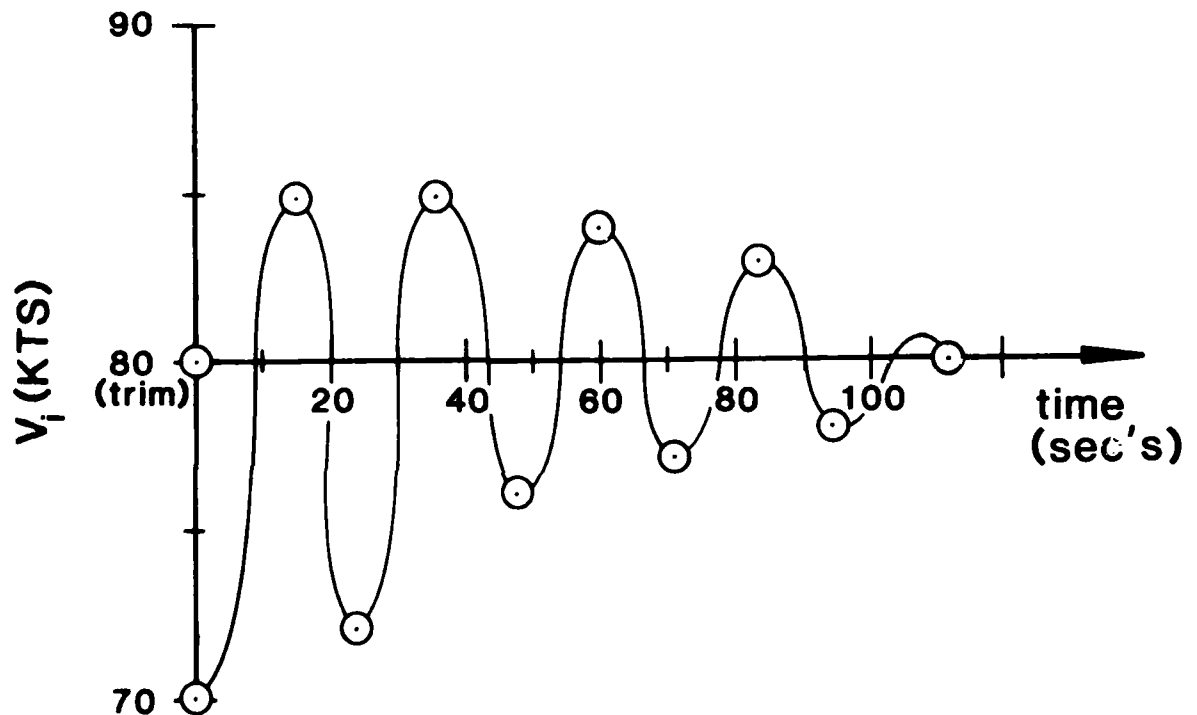
NOTE: Do this for speed where horn comes on, buffet speed and stall speed.

Beechcraft Sundowner N6014M

30 Nov'82 $V_{trim} = 80$ kts $H = 8000$ feet

C.G.=21.7% MAC

Phugoid Dynamic Mode



Data reduced using log decrement:

Period $T = 12$ sec's

Damping $z = .065$

Actual Frequency $W_d = .5236$ rad/sec

Natural Frequency $W_n = .5247$ rad/sec

Time to half amplitude $t_{1/2} = 20.23$ sec's

Beechcraft Sundowner N6014M

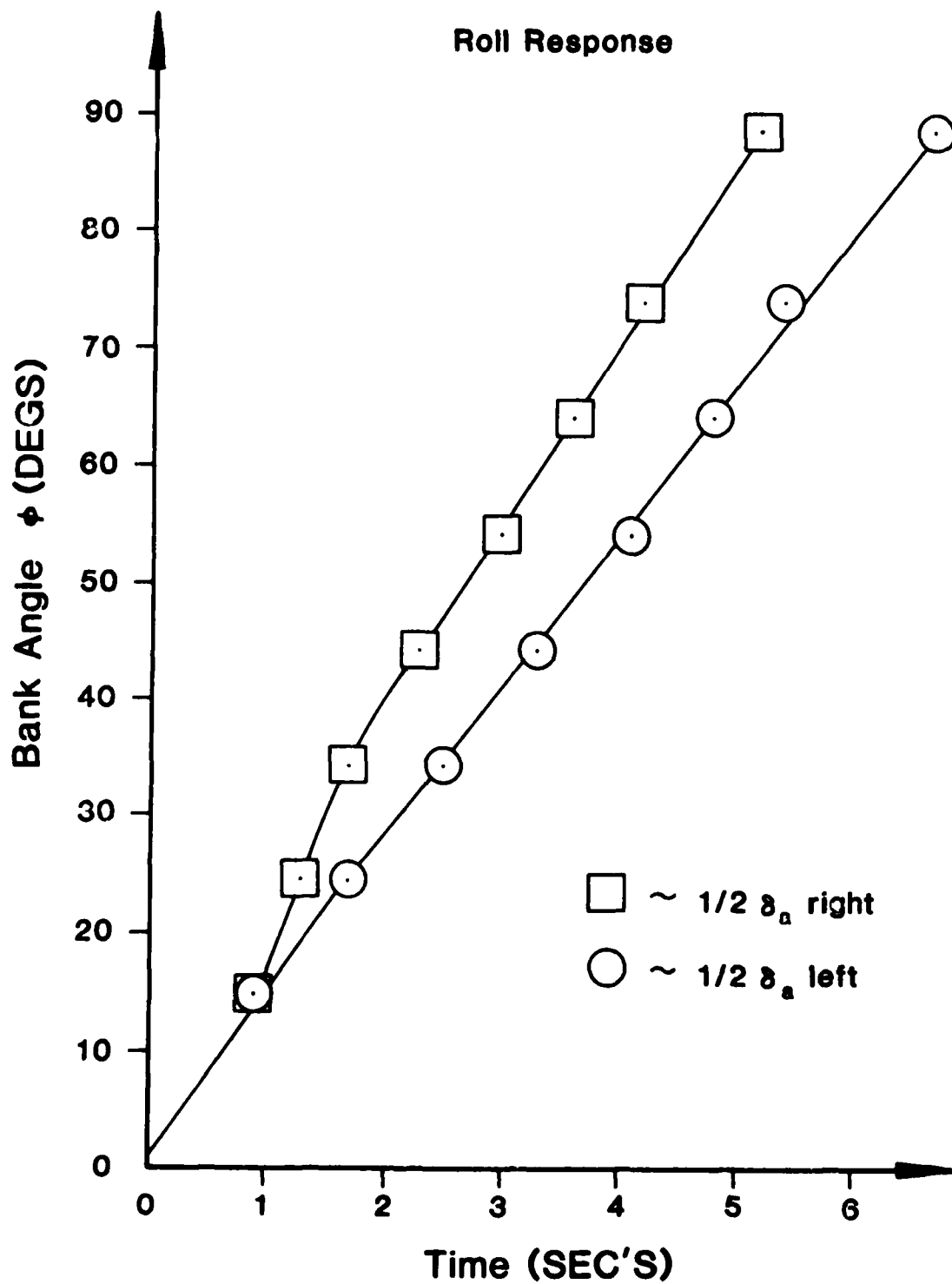
30 Nov'82

$V_{trim} = 80$ kts

H=8000 feet

C.G.=21.7%

Roll Response



END

DATE
FILMED

9 — 83

DTIC